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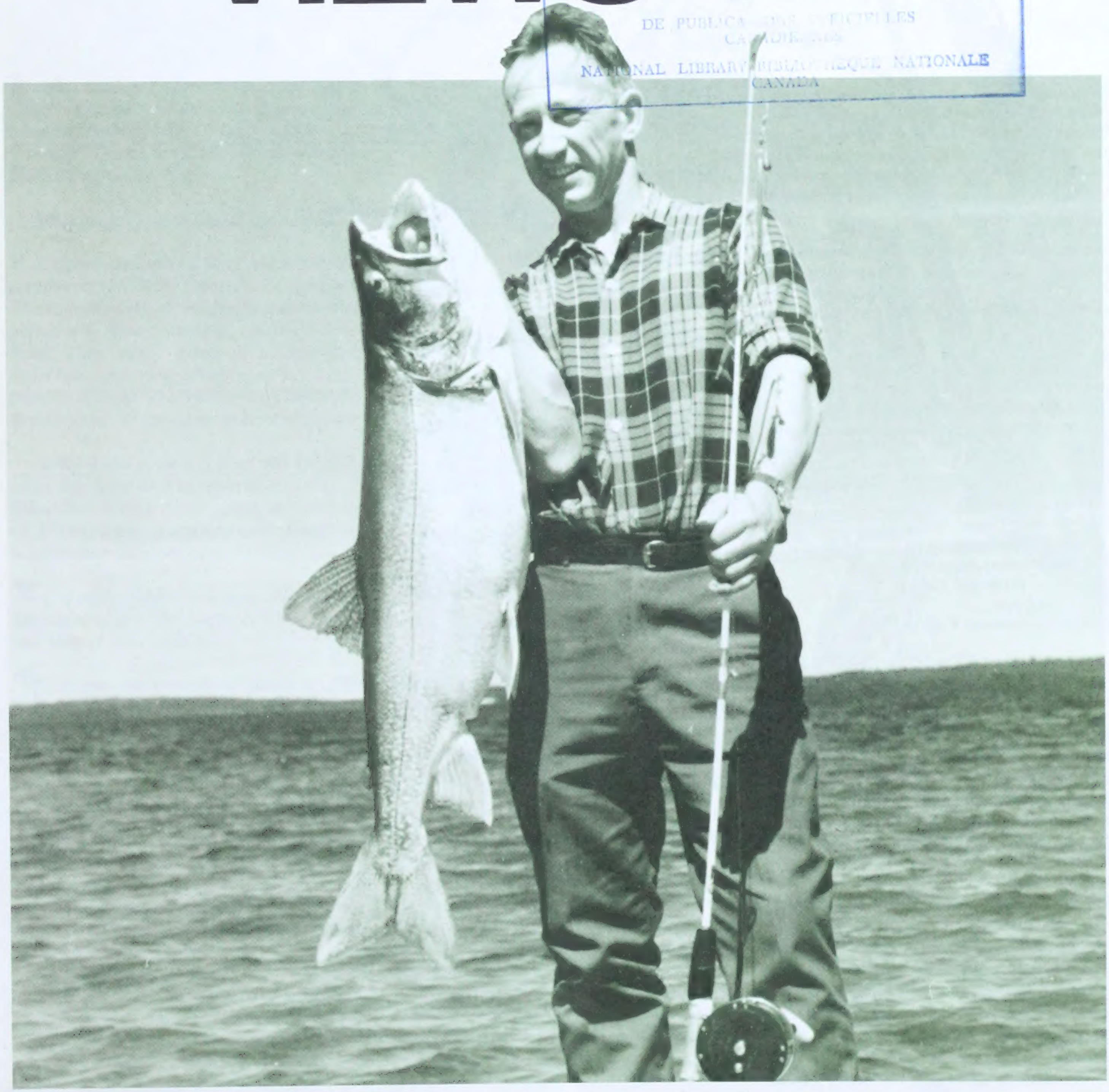

Acid rain

ENVIRONMENT VIEWS

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Alberta
ENVIRONMENT

Maryhelen Vicars

Acid Rain

The west has time to plan — will we use it wisely?

JIFFY SMELTING COMPANY
I love it when the sun shines just after a rain shower... it's so good for the garden.
warren clark

Decades ago, A.Y. Jackson painted Nellie Lake, using oil on canvas to capture and preserve the beauty and serenity of the lake. The lake in turn provided Jackson with the trout on which he lived.

Both the artist and the lake are dead.

Jackson died after a long and respected creative career. Nellie Lake died in its youth. The fish that once thrived in its waters have perished — slowly, steadily, virtually unnoticed. They were victims of acidification from rain and snow which have been polluted by sulphur and nitrogen oxides from smelters and power plants many miles away.

Nellie Lake is only one of 140 Ontario lakes that have died because of acid rain. If immediate action is not taken, as many as 48,500 more may succumb to the ravages of acidification over the next 20 years.

Acid rain corrodes buildings. Stunts trees. Damages crops. And affects your health and that of your children.

You can do something about it. The technology to control acid rain is available. But it will only be implemented if governments and the public demand prompt action.

With a portrait of the artist and a small reproduction of one of his paintings of Nellie Lake, the above text ran in a full-page ad in February's Saturday Night magazine, placed by the Ontario-based environmental research and lobbying group, Pollution Probe.

The ad makes a simple and very emotional pitch to the mostly eastern readers of the magazine to help fund the group's fight against acid rain. It is an emotional issue in eastern Canada, in a way it probably will not be in the west for some years.

While acid rain's impact has not yet been felt in Alberta, it is an international issue, and one which we cannot afford to ignore.

"As pure as the driven snow" "As fresh as the April showers" — in literature and in life, rain and snow bring to mind images of refreshing purity.

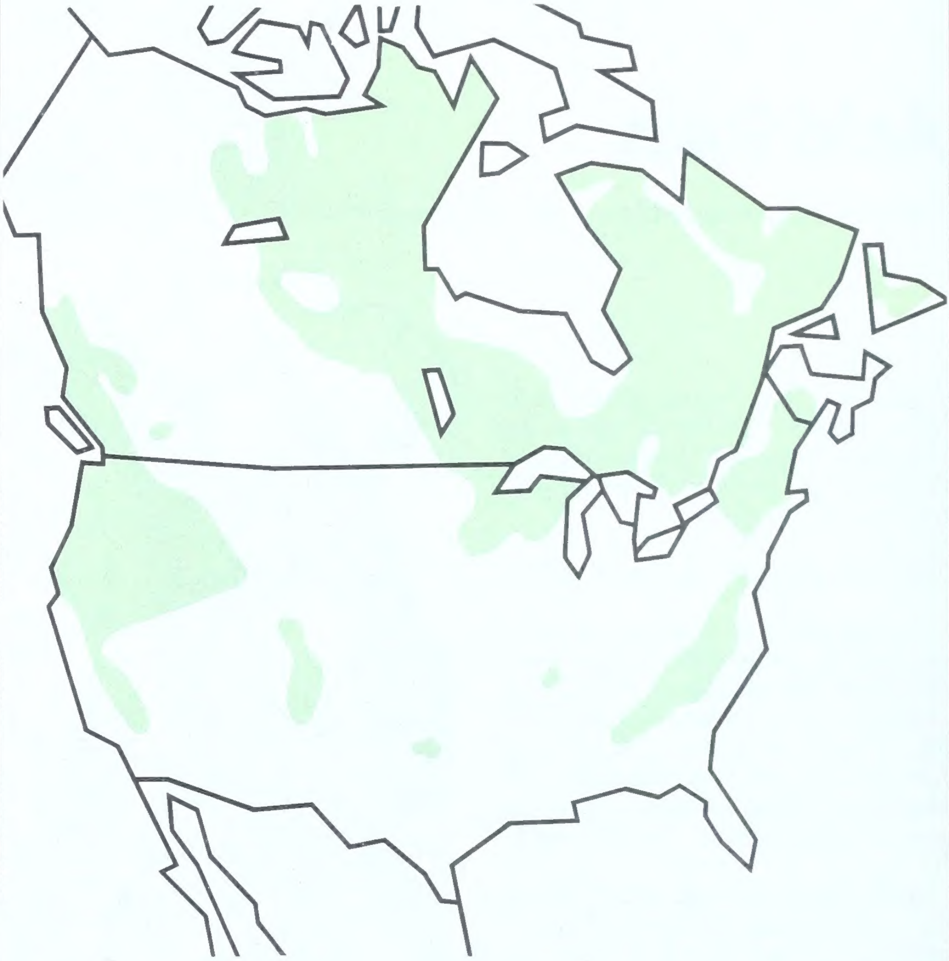
Sadly, the metaphor and the reality have become badly tarnished in recent years as the rain and snow falling over much of the earth has become dangerously acidic and destructive.

From the smokestacks and exhaust pipes of the industrialized world, vast quantities of sulphur oxides, nitrogen oxides and other particles are carried high into the atmosphere.

Transformed in the clouds to sulphuric acid and nitric acid, these airborne pollutants fall, often great distances from their source, as acidic precipitation, commonly called acid rain.

In some cases, acid rain is an environmental problem caused by curing another one. When emitters such as the huge Inco smelter in Sudbury built "superstacks" of 400 metres or more, their wastes were carried away from the immediate area, and the countryside near the smelter began to lose its "moonscape" appearance. Unfortunately, this clean-up was at the expense of lakes and fields many miles away as the ingredients for acid rain were swept away on the prevailing winds to do damage elsewhere.

Uncontaminated rain and snow is slightly acidic because water vapour reacts with atmospheric gases such as carbon dioxide to produce a weak carbonic acid solution.



Regions in North America containing lakes sensitive to acid precipitation. (Galloway and Cowling, 1978)

Lightening, volcanic eruptions and sea spray are all capable of altering the chemistry of natural precipitation, but clean rain is seldom more acidic than pH 5.6 (see pH table).

Rain which fell before the Industrial Revolution which has been preserved in glaciers and continental ice sheets has been found to be above pH 5, with some Greenland snowpacks, originating about 200 years ago, measured at between pH 6 and pH 7.

Human activities have significantly changed this. Although the acidity of rain has only in recent years been extensively monitored throughout the world, the changes are alarming and the future looks bleak.

Some parts of the world are more sensitive to damage by acidic precipitation than others. Where soils and surface water are alkaline — in areas of limestone — excess acidity is neutralized or "buffered." In these naturally buffered areas, the effects of increased acidity are minimal.

In other areas where the soil may already be acidic or where lakes and soil rest on granite or other siliceous bedrock, damage will occur quickly and dramatically, as there is little naturally-occurring alkaline material to neutralize the acidic rain and snow.

In most of Alberta and in large portions of B.C., Saskatchewan and Manitoba, lakes and soils are well buffered. An exception to this rule is the Peace country, where the soil is naturally acidic. A study has just been completed by Alberta Environment of the effect of sulphur emissions from the Amerada Minerals Corp. flaring plant near Valleyview. The plant operated for more than 25 years, before shutting down last year and piping the residual natural gas to another processing plant.

Because of the concern of farmers in the area (see story p. 12) the study was undertaken to assess the effects on soil, vegetation and water using a sulphur isotope technique. This technique is useful where the naturally occurring sulphur is a different isotope than the pollutant being measured.

Measurements were taken before and after the plant shutdown, and while the final report is under review, the preliminary conclusions show some negative effects of the sulphur — further study is needed to determine the exact extent.

As well as (generally) alkaline soils, the west is protected further by the prevailing winds from west to east, so most of the pollution which occurs in Alberta (from gas processing or tar sands plants, for example) is conveniently swept away before it can do much damage.

Moreover, there is less rainfall over the prairies than in central and eastern Canada.

To date, Alberta has been a contributor to the acid rain story, without having had to pay the price.

	SOURCE	**ANNUAL OUTPUT** (tonnes)
SO_2	gas processing plants	326,000
(1980)	tar sands plants	134,000
	utilities	73,200
	other industries	—
NO_x	gas processing plants	132,100
(1979)	tar sands plants	8,600
	transportation (trains & vehicles)	108,500
	utilities	58,900
	other industries	13,800

The gas processing plants are scattered throughout Alberta but there are concentrations in south-central Alberta, southwest of Edmonton and several large plants. Most of the thermal power plants are in the central and southern portions of the province, the tar sands plants are in northeastern corner.

From the proceedings of the Action Seminar on Acid Precipitation.

But does this mean Albertans should not have to worry about acid rain?

In a pamphlet on acid rain in the west, Environment Canada suggests that while westerners are fortunate that natural conditions offer some protection, we have a responsibility "to ensure clean air for all neighbors to the east in the same way that users of prairie rivers must preserve water quality for downstream users."

Larry Lechner, of the air pollution control division of the Saskatchewan environment department agrees. His viewpoint on the threat to Saskatchewan from rapid development in Alberta appears on page 8.

Granite bedrock areas as sensitive as those found in eastern Canada and the eastern U.S. are found in the Canadian Shield areas of northeastern Alberta, northern Saskatchewan and Manitoba and in parts of western B.C.

If we hope to protect them from the ravages of acid rain as well as to help turn around the increasingly serious damage being done to eastern Canadian lakes and forests, we will have to act quickly.

In a 1979 issue of *Scientific American,* Gene E. Litkens and others report:

> *"On an annual basis rain and snow over large regions of the world are now from five to 30 times more acid than the lowest value expected (pH 5.6) for unpolluted atmospheres. The rain of individual storms can be from several hundred to several thousand times more acid than expected."*

In the most extreme example yet recorded — a storm in Scotland in 1974 — the rain was the acidic equivalent of vinegar (pH 2.4).

In the absence of enough moisture to change pollutants to acids, particulates such as fly ash, sulphates, nitrates and gases such as sulphur dioxide and nitric acid fall to earth in dry form (referred to as dry deposition and commonly included in the definition of acid rain). These dry particles or gases can be converted to acids after deposition when they contact water.

pH What is it?

The abbreviation pH stands for potential hydrogen, and refers to the concentration of positively-charged hydrogen ions (cations) as opposed to negatively-charged hydroxyl ions (anions). Ions are electrically-charged particles into which atoms or molecules of certain substances dissociate when dissolved in water.

The positive ions are acidic; the negative ions are basic.

The pH scale, used to describe the acidity of soil or water ranges from 0 (maximum acidity to 14 (alkaline). A value of 7 is neutral.

Because the scale is logarithmic, there is a tenfold increase between one number and the next. That is, a drop in the pH from 7 to 6 indicates the acidity is 10 times greater; from 7 to 5 is 100 times greater.

The pH of normal rain is 5.6, slightly acidic due to naturally occurring carbon dioxide.

14.0 —	
12.4 —	Lime (calcium hydroxide)
11.0 —	Ammonia (NH_3)
10.5 —	Milk of Magnesia
8.3 —	Sea Water
8.2 —	Baking Soda
8.0-8.5 —	The Great Lakes (annual mean)
7.4 —	Human Blood
7.0 —	Neutral — Distilled Water
6.6 —	Milk
5.6 —	"Clean" or Normal Rain
5.0 —	Carrots
4.2 —	Tomatoes
4.0-4.2 —	Annual mean pH of rain in Muskoka/Haliburton area
3.0 —	Apples
2.2 —	Vinegar
2.0 —	Lemon Juice
0.0 —	

What are the effects of acid rain on human health?

The same pollutants which cause acid rain can cause serious respiratory illness and even death.

Sulphur dioxide, sulphates and nitrogen dioxide are among the ingredients of photochemical smog. In London, England, in 1952, weather conditions caused a thick smog to settle over the city for several days before dispersing. Four thousand deaths were blamed on that "episode."

In the U.S., scientists estimate that between 10.2 and 13.2 per cent of deaths among adult whites are caused by exposure to atmospheric sulphates.

In its 1981 report entitled *Still Waters,* the parliamentary subcommittee on acid rain cited these examples, and concluded that the reduction in emissions which would ease the acid rain problem would also ease these serious health problems caused by air pollution.

But there are more direct threats to human health posed by acid rain itself: the contamination of drinking water by toxic chemicals which can be leached from the watershed and from pipes and cisterns by acid rain; and the contamination of edible fish by toxic chemicals, principally mercury.

Neither of these hazards are widespread threats in Canada. In urban areas, the pH of drinking water is adjusted during the treatment process. In rural areas, however, many people drink untreated water from wells or other sources which may contain toxic concentrations of certain chemicals such as heavy metals.

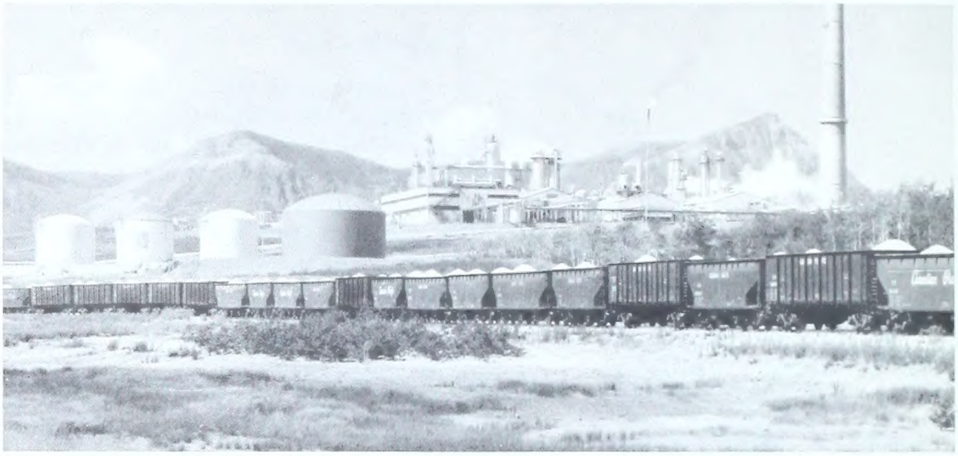
The subcommittee reports on Swedish research which found concentrations of the dangerously toxic methyl mercury in fish increased as lakes and streams became more acidic.

When people eat large quantities of contaminated fish, as in parts of eastern Canada where fish is a staple of the diet of native people, mercury accumulates in the body and can cause irreversible nerve damage (including brain damage) and may result in death in the most extreme cases.

In the Still Waters report, which offers recommendations covering research, monitoring and regulation aimed at controlling acid rain, the sub-committee called for further studies on these direct effects.

Along with other damage caused by acid rain, society must consider the cost to health in deciding whether to demand the use of expensive technology to reduce emissions.

What price should we put on good health in reckoning the real cost of this technology?



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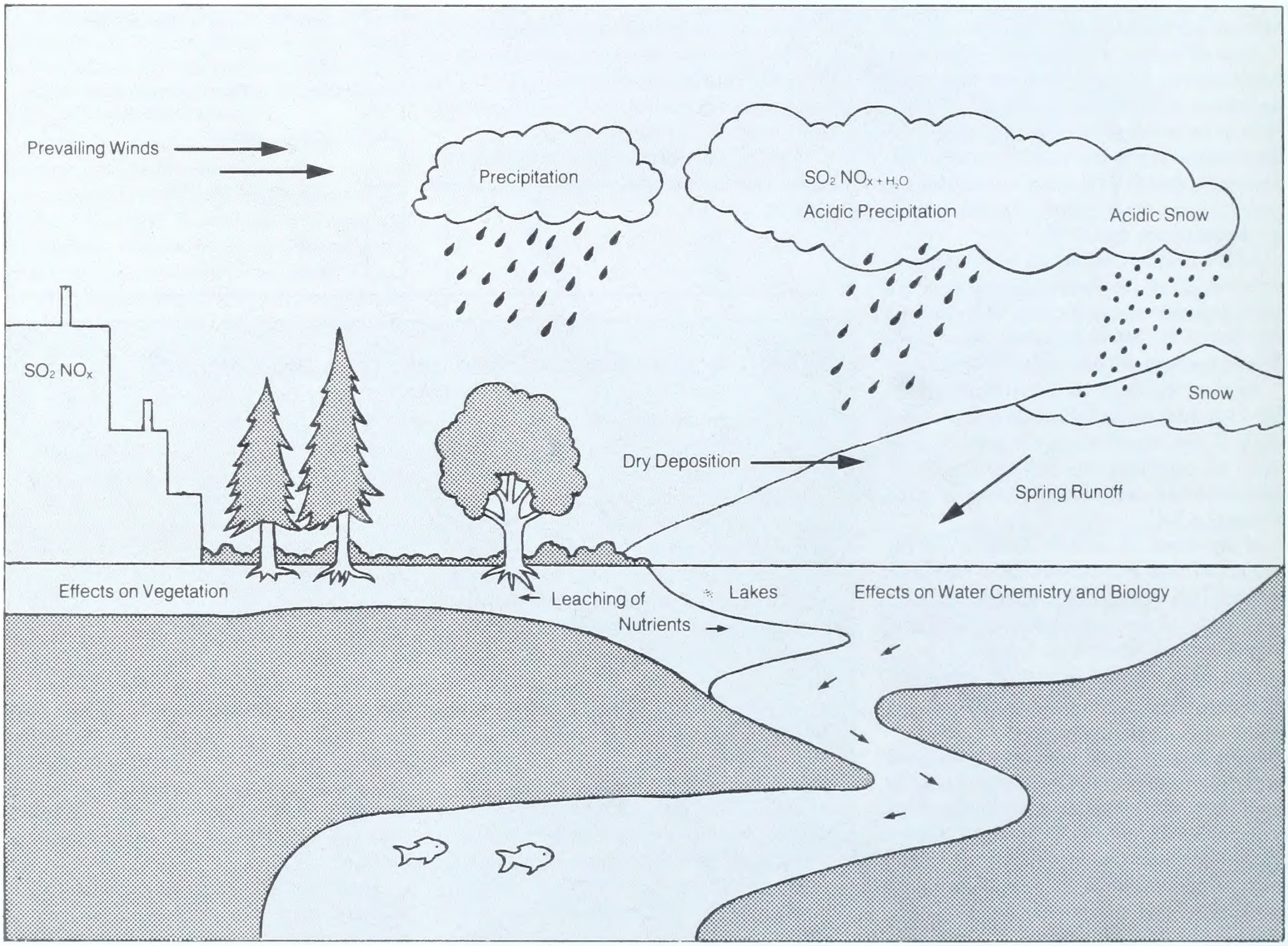


What happens to soil and to bodies of water when rain and snow are acidic? There is no short answer. As we will see in this issue of Environment Views, the impact is just now being studied intensively, although in Europe, particularly in the Scandinavian countries, the effects of acid rain have been felt and measured for several decades.

Some effects are dramatic and even poignant, as is the irreparable damage done to priceless monuments and statuary in Europe. More prosaically, some authorities blame as much as 50 per cent of automobile corrosion on acid rain, and according to other studies, the annual damage to building materials in Canada is at least $285 million.

While the details of acid rain's impact may not yet be fully understood, acid rain has been found to cause chemical changes in soil and in surface water which can in time damage plant growth, reduce soil fertility and kill fish and plant life in rivers and lakes.

In eastern Canada, there are 200 lakes which no longer support life, with many thousands more acid-stressed and in danger of irreversible damage. If present trends in acidification continue unchecked, the Ontario environment ministry estimates that 48,500 lakes could be fishless in this decade.

In the Maritimes, rivers which once teemed with prized Atlantic salmon now have a pH below 4.7. The fish are gone, and a similar fate awaits another 11 Nova Scotia rivers, if emissions continue at present levels.

The diminishing or elimination of fish populations, especially of such sensitive species as trout and salmon, is a widely observed phenomenon in freshwater lakes

Glossary

Acid A concentration of hydrogen ions in solution. Acidity is expressed on a numberical pH scale. An acidic solution has a pH less than 7.0.

Acid rain Precipitation, including rain, snow, sleet, hail, etc. with a pH less than 5.6. Acid rain consists of "wet deposition" and "dry deposition."

Base The opposite of acid; depends on the concentration of hydroxyl ions (OH-) in solution. A basic or alkaline solution has a pH greater than 7.0.

Buffer A chemical which, in solution, will resist changes in pH or, if added to a solution, will change the pH of that solution. In nature, limestone (calcium carbonate) will act as a buffer against acid rain to maintain or raise the pH of a waterbody.

Dry deposition A process whereby particles such as fly ash, sulphates and nitrates, and gases such as sulphur dioxide and nitric oxide are deposited on, or absorbed onto, surfaces. The dry particles or gases can be converted into acids after deposition when they contact water.

Leaching A natural process by which water dissolves minerals out of rocks. The leaching of heavy metals, such as mercury, into water supplies is believed to be a serious consequence of acid rain.

Limestone A sedimentary rock consisting chiefly of calcium carbonate. Limestone is an effective buffer against acid rain.

National Ambient Air Quality Objectives Prescribed by the federal government under the **Clean Air Act** to reflect regional air quality goals in three ranges — 'tolerable,' 'acceptable' and 'desirable.' They are not source-specific but are geographical area-specific.

pH A numerical expression of the concentration of hydrogen ions in solution. The units are expressed as the negative logarithm of the hydrogen ion concentration: pH 0 to 7 is acidic, pH 7.0 is neutral and pH 7 to 14 is basic or alkaline.

Scrubbing The technique of removing pollutants, particularly sulphur, as it passes through flues or stacks.

Smelter A plant in which metals are recovered from the sulphides, oxides, etc. of ore minerals. Smelting is a reduction process carried out in the dry state at incandescent temperatures.

Sour gas Natural gas which contains sulphur.

Sulphide A compound of sulphur with another chemical element.

Sweet gas Natural gas which does not contain sulphur.

Wet deposition A process of precipitation whereby acidic chemicals, including dilute sulphuric and nitric acids and sulphates, are deposited in rain, snow, etc.

and streams as they become more acid.

In addition, Likens reports several other changes to acid-stressed acquatic environments:

> *"The rate of decomposition of organic matter is slowed, presumably because of changes in the predominance of bacteria and fungi. Bacteria, which are efficient decomposers, generally do worse in an acid environment.*
>
> *"Changes occur at all levels of the food web: phytoplankton, zooplankton and fishes, all of which decrease in number of species. Even the behavior of organisms may change because of changes in their environment."*

Although adding lime and other bases to neutralize the acid can help reverse this process in acquatic ecosystems (see story p. 18), it is expensive, temporary and must be considered only a partial solution.

Damage to soil (and therefore to agriculture and forestry, vital industries throughout Canada) is less dramatic, and perhaps less well understood.

In a 1980 article in *Harrowsmith* magazine, the slower and more complex changes which accompany acidification of soil are described:

> *"As a soil acidifies, the possible transitions taking place — silent and unnoticed — include the dissolving and leaching away of essential plant nutrients; the concentration of other nutrients in amounts excessive enough to become toxic (overdosing); the concentration of highly toxic heavy metals in the soil; the destruction of nitrogen-fixing bacteria associated with the legume crops; the destruction of the soil's earthworm population; the spurring of growth of fungi which cause "stem rot" and other plant diseases; the searing of plant foliage and the destruction of bonding agents which cement soil aggregates in sizes necessary for proper tilth."*

While the technology exists to greatly reduce emissions of acid rain precursors, putting it into action is not a simple matter. The costs of drastic reduction in emissions are very high, and industry is understandably reluctant to foot the bill, although some progress is being made (story p. 29).

However, the cost of not using the best technology we have is much higher and may be impossible to measure. What value can we place on a healthy lake, or the lives of the fish and amphibians and the birds that feed on them?

It is a political problem, particularly right now, when the present American administration has opted for a "go slow" policy on further emission control, proposes to relax emission standards for automobiles and is pushing for more use of coal to help achieve energy self-sufficiency, with predictably heavier emissions.

As this issue goes to press, U.S. Senator Daniel Moynihan is urging the Regan administration to take action on acid rain, and members of the international eco-activist group Greenpeace have scaled the stacks of power plants at several locations in the U.S. to dramatize what they see as an acid rain crisis.

Here in Canada, the public and our elected representatives are becoming more aware of the urgency of the problem, and there has been some encouraging progress in the form of tougher pollution standards and good co-operation from many industries.

But on both sides of the border, there is impatience with proposals for research first — action later, the position taken by certain segments of industry. It is also the position expressed by the Reagan administration in its proposed revisions to the (U.S.) Clean Air Act.

Canada's environment minister, John Roberts, commented last fall on the proposed revisions:

"I am disappointed that the only reference to acid rain was in the context of research. I have on many occasions made the point that, while we need more research, we need reductions in acid-causing emissions urgently."

Maryhelen Vicars is the freelance editor of Environment Views.

VIEWPOINT

Larry Lechner

The west must work together *before* there is a crisis.

While arbitrary borders on land separate the western provinces, the air above them is fluid. Research to date indicates that Saskatchewan does not have an acid precipitation problem now.

While researchers say there is time to study the ecosystems in the Precambrian Shield to determine acid precipitation effects; time to determine the deposition rates which will cause detrimental effects and time to set limits to prevent these effects from occurring, there is some urgency for governments to establish a mechanism to ensure that emission limits in various jurisdictions will protect the environment and not harm other provinces.

Saskatchewan is very concerned that industrial activity beyond its border could put its northern lakes and rivers at risk.

The potential for a problem exists from sulphur dioxide emissions from heavy oil and oil sands development beyond our western border in Alberta.

The potential also exists from sulphur dioxide emissions from base metal smelting operations to the east at Flin Flon and Thompson, Manitoba. It is Saskatchewan Environment's view that this matter should be investigated at an early stage rather than waiting until there is a problem requiring a solution.

Saskatchewan's surface waters overlie a broad spectrum of rock and soil types. The northern third of the province is Precambrian in origin. All the lakes in the Precambrian Shield have a low buffering capacity and are very sensitive to acid precipitation.

In the area immediately south of the Precambrian Shield, the Cumberland Lowlands, the rocks are rich in calcium carbonate (limestone, dolomite) and have a higher buffering capacity.

The remainder of Saskatchewan is sedimentary rock covered to an average depth of 60 metres with glacial till and outwash material. There are fewer lakes than in the Precambrian Shield, and these tend to be well buffered and not sensitive to acid precipitation.

Saskatchewan does not have a large industrial base. However, resource development is expanding and is expected to accelerate over the next few years. Significant activity is occurring in the uranium mining and heavy oil industries. This industrial activity is occurring in or just south of the Precambrian Shield area. The potash industry is also expanding significantly. This industry is located in the southern part of the province. Heavy oil recovery activities are increasing substantially in the Lloydminster area. A number of pilot plants are in production now to determine the feasibility of the recovery methods. A heavy oil upgrader is also proposed for Southern Saskatchewan. The upgrader would be a source of sulphur dioxide emissions.

Increased industrial development requires more power. Several additional thermal power generating plants are being considered for the province. These would be coal fired and become Saskatchewan's largest source of sulphur dioxide emissions. They would be located in southern Saskatchewan, in the area of least sensitivity to acid precipitation.

Emissions of sulphur dioxide in the prairie provinces are currently estimated as follows: Saskatchewan - 46,000 tonnes per year; Alberta - 533,000 tonnes per year; and Manitoba - 570,000 tonnes per year.

We need to question traditional approaches to the development of industry wide standards. While uniform laws may please industry they may not be appropriate to the western Canada acid precipitation problem. Certain parts of the west are buffered against acid rain while our northern lakes may be at risk, and perhaps air pollution control strategies should reflect these differences.

The Honourable Ted Bowerman, Saskatchewan Minister of the Environment, has proporsed a meeting with his colleagues in Alberta, Manitoba and British Columbia to discuss a regional control strategy approach for the prairie provinces. We feel there is a need to reach an accord on the issue of transboundary movement of atmospheric pollutants and also to move towards a joint air pollution control strategy which will protect sensitive areas in any province.

There is another concern for Saskatchewan. It is evident that a rapid growth of emissions in Alberta or Manitoba could preclude future development in Saskatchewan because the tolerance levels in sensitive areas may have been reached by the time studies to define the problem can be completed.

We must have a mechanism or an agreement to commit each western province and the federal government to adequate funding of acid rain activities. Ultimately, the issue of transboundary movement of atmospheric pollutants can only be resolved through cooperation between the provinces.

L.J. Lechner, P. Eng., is the director of Saskatchewan Environment's air pollution control branch.

Sharon Adams

The Legal Question

Is Alberta's approach to polluters the right one?

Tim Belec

Linda Duncan

It's a tough act juggling in one hand the many benefits of industrial development with its cost to society in the other. Many Alberta environmentalists believe politicians and bureaucrats have dropped the ball — right on the public's toes.

While policies are developed with the hope of eventually achieving the best of all possible worlds — a clean environment and a healthy industrial base — many Albertans fear we'll sacrifice the former to the latter unless government is willing to crack the legislative whip.

Acid rain is one focus of concern in the continuing debate about the extent to which the quality of life must be bartered for healthy industry and the jobs, growth and tax revenue it brings.

The spectre of dead eastern lakes has also raised twin questions: whether industry in one part of the country has the right to foul the air, water and soil in another part, and who is responsible for preventing such problems.

In the inter-provincial wrangling over this issue it becomes clear Canada's constitution is at the root of the problem.

Although acid rain defies provincial boundaries, one province cannot legislate against polluters in another province and federal government action is restricted because the British North America Act gives jurisdiction in environment matters to the provinces.

The federal government can set national air quality objectives in its Clean Air Act, but the provinces must individually subscribe to those objectives. While it can set emission standards for pollutants endangering human health or violating international agreements, most polluters fall outside those definitions.

According to some critics, two very powerful federal tools are underused: the regulation of composition of fuels for industry (similar to cutting the lead content in gasoline); and the use of the persuasive power of massive spending programs.

The federal government could give money to the provinces to assist in controlling pollution, financing pollution control research or industrial conversion or simply to help industry clean up.

But it is the provincial governments which come under the closest scrutiny and garner the greatest criticism for the growing acid rain problem.

In 1971 Alberta's minister of environment decided the provincial policy would be to develop the toughest pollution objectives in the nation in the Clean Air Act.

But that legislation does not make it illegal for polluters to exceed the objectives; the legislation is backed by regulations which polluting industries themselves help to develop; and compliance with the regulations is assured by monitoring — again, done by the polluters.

One environmentalist said this makes about as much sense as inviting a crook to help write the criminal code. Another called the system "harebrained."

While critics complain application of the provincial objectives is weak, they agree with the bureaucrats that the legislation is strong.

"There's no magic in legislation," says Linda Duncan, executive director of the newly-formed Environmental Law Association, located in Edmonton. "That's not to say it couldn't be improved. But what's the point of having good standards if you're not going to enforce them?"

She questions the wisdom of having civil servants act as enforcers.

"It isn't even a question of the willingness or eagerness of civil servants to enforce the law. The question is: Is it appropriate? Should it be in the hands of people without strong bargaining power against industry?"

Duncan believes air quality violators should be treated the same way as other lawbreakers — in court.

"It's just like speeders; they are ticketed by police, but sentenced by the courts."

Setting of the ambient air quality level (local ground level concentration of pollutants) is a policy decision. The minister must decide how much pollution in the local environment is acceptable. The maximum level can be set, as it is in some parts of the U.S., at the point where public health is endangered. Or it can be much lower, as in Alberta's case.

Environment Canada lists three levels: maximum desirable, the long-term goal for air quality and environmental protection; maximum acceptable, the realistic operating standard; and maximum tolerable, the limit marking risk to health.

Jerry Lack, head of Alberta Environment's pollution control division, says Alberta has the toughest objectives in the country and "there's a margin of safety built in."

Because the objective is well within the limit which could pose a danger to health or environment, "There's quite a bit of leeway. When a company has exceeded the standards, we don't get too excited, but the public believes that as soon as a company is over the (objective), leaves start falling off trees and babies start to cough."

The province's big stick lies, not within the Clean Air Act's ambient objectives, but in the ambient standards set out in the regulations companies must meet to obtain and renew five-year operating licences.

Maximum source emission levels are stipulated in these licences as well as design standards, the necessary pollution control equipment and a schedule for meeting the latest standards, should the standards change while the plant is in construction.

It is an offense not to comply with these conditions. However, the companies help establish these regulations and help determine what equipment is feasible to install and over what time period.

So while government sets the ambient objectives with long-term public benefit in mind, industry, which "has in many instances more expertise" has "direct input into the design of draft regulations" setting source emission standards, Mr. Lack reported in an October paper on Alberta Environment's Approach to Industrial Air Pollution.

Tim Belec

Serge Dobko

Lack points out this, too, was a policy decision. Under the theory that the carrot is more effective than the stick, Alberta Environment is encouraged to co-operate with industry.

As well, Lack pointed out in his report, using the stick can be costly.

"Court action is time consuming and costly and often, while the court case drags on, the violation continues. Enforcement can be achieved most effectively through technical discussions rather than reverting to an adversary system."

However, Ms. Duncan says the department is hardly in a position to judge since it has not used both methods and there is no valid basis for comparison, other than the hundreds of prosecutions undertaken annually in other provinces.

Serge Dobko, of Alberta Environment's standards and approvals division, which issues licences and permits, argues that through negotiation it begins to appreciate industry's problems, and ensures compliance. Industry then knows the regulations were approved after informed decisions were made.

Dr. Martha Kostuch, past chairman of the Environment Council of Alberta's public advisory committee, says the legislation must be revised to include the public in the negotiations.

"The number one recommendation the committee made to the ECA was that there be a review of all aspects of air pollution, including public hearings, a review of legislation, regulations, enforcement and monitoring."

Dobko says the regulation negotiations allow his branch to constantly upgrade regulations. It can keep abreast of innovations and react quickly to new developments in industry. The branch issued 350 construction permits and more than 600 operating licences in 1981.

"Each permit and licence," he said, "is a mini-regulation."

Industry first applies for a permit to construct which outlines design criteria, regulations for pollution control equipment, and height of stacks.

Stack height design objectives are supposed to lower the local effects of short-term pollution which exceeds the standard. Stacks must be high enough to ensure local emissions still fall within acceptable limits in the worst weather conditions with the plant's pollution equipment operating at minimum efficiency.

Since it can take up to five years to complete construction, the original pollution control equipment can be obsolete by the time the plant opens. So when the plant is ready to open, it is given a five-year operating licence. Condition of licence can include design standards, retrofitting of better pollution control equipment and a time line for meeting new standards.

Two measuring sticks are used in setting the limits for the operating licence: best available technology and best practicable technology.

Available technology (BAT) can be required to be installed regardless of cost when a pollutant poses a danger to human health. BAT is required in Alberta in vinyl chloride and polyvinyl chloride plants and secondary lead smelters.

Best practicable technology (BPT) is that in general commercial use.

Again, industry helps determine the standards. BAT and BPT are determined by either Alberta Environment-industry or provincial-federal-industrial task forces. The province normally adopts the task force results.

though Lack says it is department policy that "the polluter pays" for installation of new or upgarding pollution control equipment, these task forces also advise on "realistic" schedules for implementation of new technology.

In addition, the minister can use that same flexibility to waive, in certain cases, the imposition of regulations which allow the department to insist on best design standards.

For a specified period he may suspend the regulations if he feels a company cannot meet them because of an accident or other unforseen circumstance. This would be done if the resulting pollution poses no danger or if not easing the regulations would result in hardship to the company in question without an offsetting benefit to anyone else.

Dobko says this flexibility is important in ensuring industry — and the jobs so vital to a healthy economy — survive.

For example, Alberta Environment has been considering requiring a reduction in flue dust emission levels to 90 grams per 450 kilograms pounds of flue gas in provincial foundry operations. But the cost to industry would have been nearly double the cost of the foundries themselves. Industry was able to afford to put in equipment to reduce emissions to 200 grams per 450 kilograms.

"If the government had insisted, it would have shut the foundries down. Since they're important to local manufacturing, to the water and sewer works, to other small businesses which would otherwise have to bring materials in from out of province, we lowered the standard."

Dr. Kostuch suggests it might be cheaper in the long run to set tough standards, then make industry pay for exceeding them. The fees, paid in proportion to the amount released in excess of the standard, could go into an environmental resource fund which will be vital eventually when "we have to start doing some reclamation."

Now, she says, industry is given a bye, but the pollutants' effects are piling up in the environment. It could be more costly to clean up in the long run — much more costly than suffering some economic setback today, she says.

Finally, after industry is operating under regulations with a five-year license, the government enforces its laws by monitoring and reporting — which the industries themselves do with occasional help from the department.

Though industry is warned about the importance of proper monitoring and reporting, the public is skeptical.

Lack, in his October report, said companies which for example, do not report instances of emissions exceeding allowable levels within 72 hours are subject to prosecution.

The time limit for reporting is enforced so the department can decide on a "corrective program or legal action." The credibility of the department and industry can be seriously eroded if the general public discovers the mutual-agreement policing isn't working.

If monitoring shows a company is exceeding standards set out in its license, the department has a four-part enforcement plan.

First, the department will try to negotiate a settlement and time frame for compliance. If that fails, it issues an emission control order. If that fails, the department either prosecutes or, finally, seeks a ministerial stop order.

"Any one of these four is enforcement," complains Lack. "But the media tends to put the emphasis on prosecution."

He says by taking the conciliatory approach, the department has been able to get companies to devote millions to upgrading plant operation and pollution control equipment — voluntarily.

But Linda Duncan is unimpressed with that stance. Meanwhile, tons of pollutants are pouring out of the plants into the air and the water and onto the land. When it comes time to clean it up, the company may no longer even be in business, she points out.

Prosecution rather than negotiation would result in companies complying earlier and helping bear the burden of clean-up, she believes.

As well, it would help overcome the public's perception of a "cosy" relationship between the department and industry.

Sharon Adams is a journalist in Calgary

Alberta Government Photo

All the gung-ho development of energy megaprojects in northern Alberta has resulted in great optimism about the creation of new jobs.

That's just fine, say the people in Saskatchewan, but they're wondering if Albertans realize that, unless efforts are undertaken to eliminate dangerous emissions from oil sands plants, jobs in Alberta would be created at the cost of hundreds of existing jobs in northern Saskatchewan.

There is already high unemployment complicated by low education levels in northern Saskatchewan. Other than tourism and commercial fishing, there is little job-producing activity. A study by the Department of Northern Saskatchewan concluded that if sulphur dioxide (SO_2) and nitrogen oxides (NO_x) continued to fall into the 60,000 sensitive lakes in the area, most would be affected and most would be lost to tourism and commercial fishing, a cruel blow to the 23,000 residents of that area.

Still, this is a distant threat, and one which allows plenty of time to take remedial action. If acid rain is seen as a painful rash on the landscape in certain parts of the world, in western Canada it would be little more than an irritating itch. Occasional samples of rain with a pH as low as pH 4.6 have been recorded in the western provinces. And some communities downwind of natural gas processing plants are beginning to blame the emission of sulphur dioxide from those plants for specific problems of human and domestic animal health.

Western Canada has no dead lakes to blame on acid emissions and no denuded "moonscape" terrain as in Sudbury, Ontario. Still, the itch is serious enough to cause alarm and the desire is arising in various groups and individuals to reach out and treat the problem before it becomes grave.

One of the first steps is to improve and intensify the research and monitoring effort. Dr. Harby Sandhu, senior research manager for Alberta Environment, says it is essential to intensify the rainfall monitoring effort and to develop a reliable system through which politicians can be warned in time to prevent damage.

Much of the soil and water in western Canada is easily able to neutralize acids. But no matter how good the environment is at buffering acid, there comes a point when reistance breaks down, Dr. Sandhu says. "It's like the human body. The system may be going smoothly, but suddenly there are no more antibodies." At that point, a human being becomes ill or dies; an environment becomes unable to support life.

The provinces of western Canada are seeking ways to co-operate in the effort to understand acid rain. "We are all concerned about it and have recognized the potential threat," says Dr. Sandhu, who is the chairman of an interprovincial technical committee on the long-range transportation of air pollutants and acid rain in the four western provinces.

The most vulnerable areas in Western Canada include the British Columbia coast and the northern portions of Manitoba, Saskatchewan and of Alberta within the Precambrian Shield. Another small area within Alberta which might be especially vulnerable is the northern agricultural area of Peace River. There, soils are naturally more acidic than those in the south, and research is on-going to determine the ability of that northern soil to buffer more extensive acidic emissions. An area in the extreme northeast of British Columbia is also vulnerable because of the already high pH of organic soils in the swampy forest zone.

The problem Saskatchewan faces with acid rain in its northern zone is very little of its own making. Federal environment department figures show Saskatchewan's annual emissions in 1976-77 at 41 000 tonnes of SO_2 and 130 000 tonnes of NO_x. Meanwhile, the Suncor plant in Fort McMurray was emitting 93 000 tonnes of SO_2 in the same years, some of which is believed to be landing on northern Saskatchewan. To the east is the Hudson Bay Mining and Smelting

Lake Athabasca in Alberta's acid rain sensitive Northeast

Shell's gas separation plant at Jumping Pond

Co. Ltd. plant in Flin Flon, Manitoba, suspected of sending at least some of its 212 000 tonnes of SO_2 annually into Saskatchewan.

It is possible that Alberta's emissions of SO_2 from power generation through combustion of coal will increase four-fold by 2005 to 312 000 tonnes. And the potential increase from northern oil sands projects is even more staggering.

The most conservative estimate comes from Syncrude Canada Ltd., which informed the parliamentary subcommittee on acid rain that current emissions of 134 000 tonnes of SO_2 per year from two oil sands plants would double to 336 000 tonnes annually. A considerably higher projection was made by Dr. U.T. Hammer in a report to the Saskatchewan Environment Advisory Council. He suggested that by 2006 four *in situ* oil sands plant splus four mining oil sands plants could emit about 628 000 tonnes of SO_2, including sulphur produced by the combustion of subbituminous coal in the *in situ* plants.

In its report, the subcommittee estimated that total emissions from oil sands, natural gas processing and electricity generation in Alberta would be in excess of one million tonnes in 2006.

"The acid rain problem cannot be solved by one province alone. Our plans are to meet at a fairly high level with people from the other western provinces and find out what their plans are," says Larry Lechner, director of the air pollution branch of Saskatchewan Environment.

The consequences of continuing acidification of northern lakes are of great concern. Precipitation with pH of 4.6 has been measured in the Cree Lake area and a report prepared for the Saskatchewan Environmental Advisory Council in 1980 concludes that acid rain is now falling in the Precambrian Shield area and will eventually cause environmental damage there.

The Saskatchewan investigation showed that, in 1975, 62 000 recreational fishermen enjoyed their sport on northern lakes. They spent $12.8 million on travel and accommodation and another $10 million on major equipment. Of that total, about $8 - $10 million was spent in Saskatchewan. Despoilation of the lakes would put 275 fishing camps out of business, resulting in the loss of 660 jobs. It would also put an end to commercial fishing, which now employs about 1 800 northern Saskatchewan people, most of them heads of households.

While Alberta exports much of its potential acid rain problem through the atmosphere there are certain indications of problems arising at home. Domestic animals are showing unusual disease symptoms downwind from some natural gas plants, and there is beginning to be concern about the effect of gas plant emissions on human health.

Proof of the effect of acid rain on humans and animals is hard to demonstrate. The most prominent case of suspected human health damage is in the Pincher Creek area, where residents have complained for 20 years about fainting spells, nausea, vomiting, unexplained screaming fits by babies and other problems. Studies by the University of Alberta, the University of Calgary and Alberta Environment have been unable to link the problems to emissions from nearby gas plants.

Dr. Martha Kostuch, a veterinarian from Rocky Mountain House, is a member of the public advisory committee to the Environment Council of Alberta. She was critical of the decision by the provincial social services department not to go ahead with a more definitive study of the Pincher Creek problem, and said that environment groups must continue to press for change without resorting to scare tactics.

Dr. Kostuch was instrumental in starting the Prairie Acid Rain Coalition. So was Herman Boerma of Saskatoon, national president of Friends of the Earth, a federation of environmental action groups, and of the Saskatchewan Environmental Society. While he admits that proof of the sources of acid rain isn't conclusive, he says action should still be taken to immediately reduce the emission of sulphur from smokestacks. "We shouldn't wait until the research is done and the proof gotten. It's very easy to build these controls into new plants and much harder to retrofit existing plants."

For Saskatchewan Environment acid rain has become the major environmental concern of the '80s. "There are lots of local problems," says Larry Lechner. "But as a total problem for the whole province there's nothing to beat it. It's taking up a lot of time."

Saskatchewan has none of the natural gas or massive oil sands plants that threaten a rapid increase in air pollution in Alberta. Only one large energy project is planned in

Sulphur stockpiling near Rocky Mountain House

Alberta Government Photo

Saskatchewan, a heavy oil upgrading plant which has yet to be assigned a final location. Mr. Lechner says that despite assurances that the plant will produce no more sulphur dioxide than an oil refinery, his staff is in the process of defining emission limits for the plant.

In British Columbia, where vulnerability to acid rain is particularly high, rain samples at several coastal monitoring stations show pH ratings in the vicinity of 5.0. A flurry of activity to locate the source of emissions responsible has resulted. There is also an effort to determine whether the "normal" pH of rain should be set at a number lower than the standard of 5.6. Throughout the coastal region, up to and including the Coast mountain range, the land has little buffering capacity either because it is situated on granite bedrock or because the buffers have already been leached out by the naturally more acidic rainfall.

Rick Wilson, of the air studies branch of the B.C. ministry of the environment, suggests that because air coming off the ocean is so clean — not containing any natural buffers such as airborne alkaline dust in the prairies — any injection of acid-causing emissions is enough to tip the balance toward acid. "There might have to be very strong controls, or encouragement of certain industries not to locate on the coast," he says.

One possible element of that strict control could be regular testing of automobiles for excessive emissions of nitrogen oxides. It is possible that the high concentration of population in B.C.'s lower mainland — and the resultant concentration of automobiles — is a large part of the reason for the low pH of coastal rains. A study was conducted in the summer of 1981 to determine the degree of reduction in NO_x emissions possible if cars were properly tuned. One recommendation that might be contained in the report, when completed, is that the existing provincially-operated vehicle testing stations upgrade their equipment to include a safety test for emissions.

There are a number of other sources of acid pollutants in British Columbia, though they are in the interior where weather systems would not be likely to spread pollution to the coast. In the northeast there are gas processing plants, and there are several non-ferrous smelters in the interior. Throughout the province there are small pulp mills that emit small amounts of SO_2.

Public awareness and concern about acid rain in British Columbia is at a "fair level", says Mr. Wilson, and many letters to the minister of the environment indicate the people consider the issue to be of importance and one in which sacrifice will be accepted as part of the cure. The tone of many of the letters is exemplified by the comment: "If it would help the environment to be healthy for my kids, I'd be willing to give up some of my electricity consumption."

In the meantime, studies are continuing into the possible effects of acid precipitation on the valuable British Columbia fisheries, and the forest industries are expressing "cautious concern" about potential losses to their industry as a result of acid rain.

Reg Silvester is a freelance writer in Edmonton.

Cheryl Cohen

Acid Rain in Eastern Canada

For the eastern provinces, the time for action is now.

For acid rain, the east is where it's at. Hogging seven spots on the federal goverment's Top 10 list of Canadian sources of sulphur dioxide and in direct line of fire from wind-dispersed U.S. acid-rain-causing emissions, eastern Canada is very much the big acid rain region of the country.

Leading the way is Ontario, home of what may be the biggest single source of sulphur dioxide in the world - the Inco Ltd. smelter at Copper Cliff.

Latest figures put the province's annual emissions of acid rain components sulphur dioxide and nitrogen oxide at 1 694 000 and 500 000 tonnes respectively.

In Quebec, the equivalent sulphur dioxide figure is around one million tonnes, while in the Atlantic provinces the annual sulphur dioxide output is about 500 000 tonnes.

It is not surprising, then, that the most information and research on acid rain in Eastern Canada centres around the Ontario situation.

In the 1980-81 fiscal year, the Ontario Ministry of the Environment budgeted 4.2 million for its Acidic Precipitation in Ontario Study (APIOS) "and this year it should be close to 7 million," says Judy Mittermayer of Toronto, assistant co-ordinator of APIOS.

Mittermayer rattles off a stream of acid rain study projects the department is involved in, including devising an up-to-date inventory for Ontario of pollutants and feeding the data into a computer system geared to the North American acid rain scene in general.

Ontario's environment ministry has come up with various reports and studies — a March, 1981, report for example evaluated 1 524 of Ontario's 250 000 lakes in an acid-sensitivity survey and found that 81 lakes (five per cent of the sample) were acidified, 186 extremely sensitive (12 per cent), 487 moderately sensitive (32 per cent), 239 registered low in sensitivity (16 per cent) and 531 (35 per cent) were not sensitive.

Further monitoring has shown a steady 44-odd per cent of the lakes sampled are sensitive to acid rain, Mittermayer says.

The ministry is studying the socio-economic effects of acid rain on the tourism industry. Muskoka-Haliburton, which is cottage country to many Torontonians and a good tourist area that attracts many American fishermen, is known to be acid-sensitive and is the focus of an intensive study that will be used to develop models and extrapolate to other areas — as well as effects on forestry and agriculture, and materials damage.

Ontario isn't yet prepared to quote any definite findings. Senior economist Jack Donnan says three or four consultants' studies are being reviewed and "any estimate produced is going to have a probability implicitliy or explicitly attached to it . . . we'll hopefully be able to establish the range."

But if Ontario seems to have come up with few definitive comments after some years of study, the situation is even less defined further east.

"Quebec has a very sensitive environment but their studies haven't been very extensive," notes Mittermayer. "They definitely have a problem, but they just haven't looked into it in the same depth."

Admits Dr. Gaston Paulin, director of research for the Quebec Environment Ministry, from Quebec City: "We started a bit late with respect to some other provinces."

It's been "about two years now" since Quebec started "doing something" and, Paulin says, "we're just scratching the surface."

Acid rain pollutants reach Quebec from Ontario and the U.S. midwest. Paulin says 16 per cent of the acid rain in Quebec is of Quebec's own making, while 25 per cent comes from Ontario and close to 60 per cent from the U.S.

Quebec has "more or less formal relations" on acid rain with two U.S. states, Vermont and New York, "to help them when they go to Washington to apply pressure on the U.S. government to stop or diminish the emissions".

"We're also working in our own yard -we have reduced emissions for the last four years, slightly."

Plans are for sulphur dioxide emissions in the province to be reduced by 27 per cent by 1985.

Studies on the go include one on acid rain and the sport-fishing industry and one to assess the economic impact of new emission controls on Noranda Mines Inc. (the top sulphur dioxide source in Quebec).

There are "no figures yet" on economic impact, but six months ago the environment department brought together four other ministries for a five-year research plan in which each ministry will investigate the impact of acid rain in its own field — "We know there must be something." The project is scheduled to begin April 1.

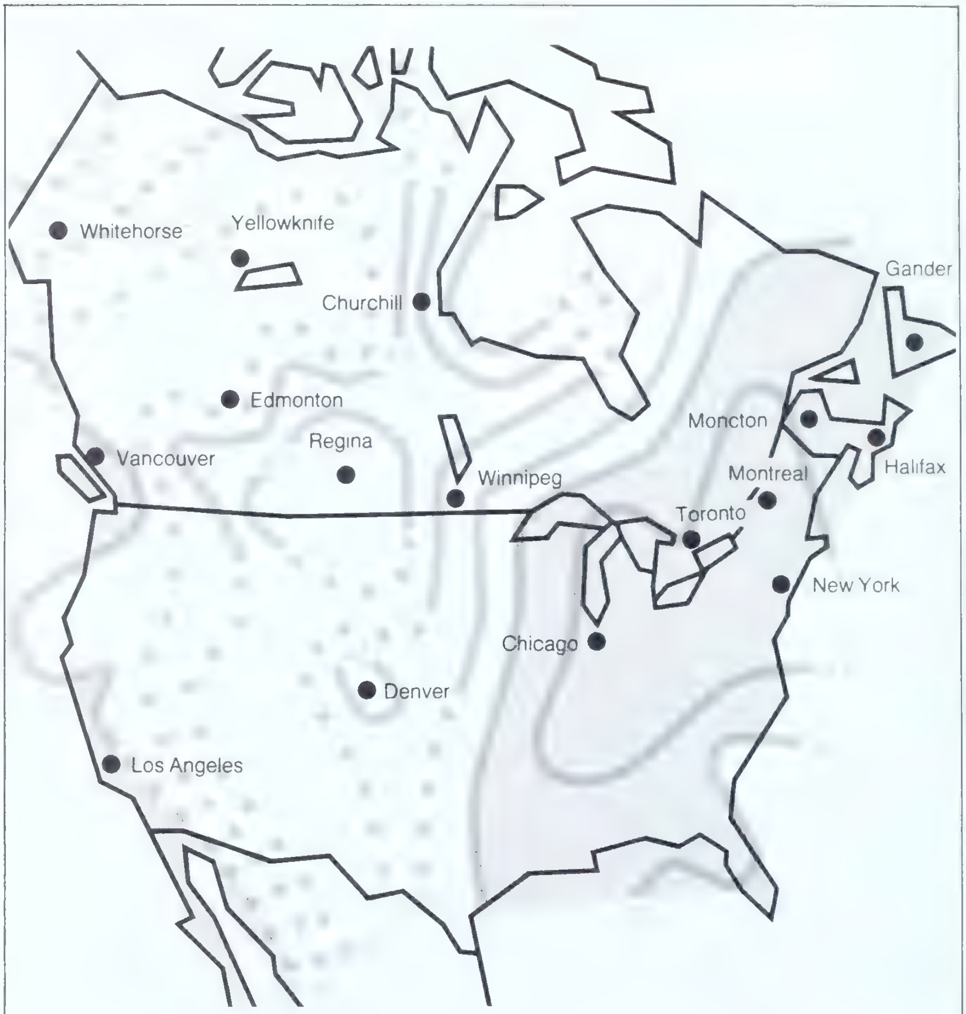
Quebec has big figures to worry about. Its forestry industry for example, is worth $3.9 billion a year, including a 2.9-billion export market. Agriculture is a 2.2-billion-a-year industry. Also, 10 per cent of southern Quebec is water and Paulin sees sport-fishing as the first area that would be hit in the tourism industry.

About half of Ontario's acid rain is of someone else's making (i.e. it comes from the United States). Quebec imports about 85 per cent of its acid rain. And the trend continues in the Atlantic provinces.

"We're the receptors" of acid rain, says Brian B. Barnes, deputy minister of Environment for New Brunswick, who has represented the Maritimes at Memorandum of Intent talks between Canada and the U.S.

The Atlantic provinces get their acidic precipitation from the eastern seaboard and from across the continent.

New Brunswick soils and water bodies have a poor buffering capacity and the buffering capacity of southern Nova Scotia is also relatively poor.



Acidity of precipitation 1976-79. Lines join points of equal pH. Map based on measurements from Canadian CANSAP network of monitoring stations and a composite of 10 networks in the U.S.A. (After Wisniewski and Keitz, 1980)

Dotted lines indicate sparse data; general pattern only.
Shading shows areas where precipitation is more acidic than pH 5.0.

But, "in terms of impact, we have not had any lakes go bad in New Brunswick yet - we don't really have many lakes in New Brunswick," Barnes notes.

In Nova Scotia, however, where there are also few lakes, pH levels are low in some southwestern rivers.

The two provinces are monitoring to see if "some areas are on the edge." Barnes says he thinks everyone agrees that, if discharges continue with no abatement, there will be problems.

"This is a continental problem," he adds. "Both countries (the U.S. and Canada) have to take some action together."

Meanwhile, as the eastern provinces battle to establish what impact acid rain is having in their back yards, they have little trouble pinpointing specific contributors to the acid rain problem.

The industrial heartland of the United States is obviously a big contributor. But, until Canada and the U.S. get going on a concerted joint control program, many people feel there is little the provinces can do to stem the flow of pollutants from the U.S. to Canada.

There is much skepticism, too, about anything concrete happening while Republican Ronald Reagan is U.S. president. Mr. Reagan has clearly indicated energy self-sufficiency — which means much heavier reliance on burning coal — is of greater priority than pollution control.

Returning, then, to Eastern Canadian sources, utilities contribute their fair share to sulphur pollution. Ontario Hydro pumps about 500 000 tonnes a year of sulphur dioxide into the air from its coal-fired generating plants, for example.

But smelting operations are the biggest source of sulphur pollution in Eastern Canada.

The Inco smelter at Copper Cliff in the Sudbury area is easily the biggest single source of sulphur dioxide emissions. It is the biggest single source in North America and, probably, the world.

It is also the primary target for public concern about sulphur dioxide emissions. And there have been accusations that companies such as Inco and Falconbridge Nickel Mines Ltd., also with a smelter at Sudbury that is number eight on the list of the 10 largest sources of sulphur dioxide in Canada , have been able to manipulate governments trying to lower emissions.

Charles Ferguson of Toronto, director of government programs for Inco, brushes aside such talk. Inco has made a "significant address" to the problem of its contributions to acid rain "and we are committed to it further," he says.

"We recognize we're politicized," Ferguson says, adding it is inevitable. If his were the 10th largest sulphur dioxide emitter and No. 1 was not getting more visible pressure to curb its emissions than he was, he says he would wonder what was wrong.

The fundamental reason for all the sulphur emissions is the sulphur-rich nature of the ore at Sudbury. For every 0.5 kilograms of nickel and copper mined, Inco and Falconbridge end up with 3.6 kg (compared with 0.5 kg in other areas) of sulphur.

A 1980 Ontario Environment Ministry publication noted that Inco had cut its total sulphur dioxide production at Sudbury by more than 40 per cent since 1969 by the production of sulphuric acid and that this, plus the superstack diversion introduced in 1972, had produced "substantial air quality improvement" in the local Sudbury area, "which at that time was the primary objective."

From the start the big stack was identified as an interim pollution control measure, Ontario says.

Some argue this is not the case, that it was no control measure at all since the government issued its "order" demanding the superstack 17 months after Inco had first announced plans to build the new stack.

There have been complaints that Inco continues to defile the environment to the extent it does simply because it would lose profits by becoming more environment-conscious.

Ferguson admits Inco is not keen to take expensive measures, for example putting in scrubbers at the old smelter aimed solely at reducing emissions.

He says Inco wants to find ways of decreasing its emissions that would have mutual benefits - helping the environment as well as updating production methods and increasing efficiency.

The company is currently testing a new smelting process at Thompson, Manitoba, which would allow a much higher degree of sulphur dioxide containment by taking a "significant amount" of sulphur dioxide out of the flue and converting it to sulphuric acid. If successful, the new process would also be profitable.

"By the end of the year we should have finished our testing and evaluation," Ferguson says.

The government has "given us time" to develop alternative processes, Ferguson says. Inco is currently under orders to reduce emissions to 1 950 tonnes a day by 1983. Ferguson says he thinks Ontario is waiting for Inco to make a decision on its new smelter before ordering anything further.

A federal-provincial task force is examining ways and means of reducing emissions at Inco and Falconbridge. Its report is due in 1982.

Cheryl Cohen is a journalist in Edmonton

Lisa Fairweather

Coping With Acid Rain

Researchers in North America and Europe find no quick fix.

Alberta Government Photo

Sulphur dioxide has a double sting: it causes acidification and other effects near its source and it contributes to acid precipitation miles away.

In Alberta, we don't feel any measurable effect of acid precipitation, although in eastern Canada there has been widespread damage and in Saskatchewan, officials are viewing Alberta's energy industry development with alarm.

How can we cope with this growing problem? Are there any simple solutions?

Let's examine our neighbor's problem, or potential problem, first. About 70 per cent of Saskatchewan north of the 54th parallel is Precambrian Shield country. There are 84,000 lakes in this northern region. If sulphur dioxide (SO_2) and nitrogen oxides (NO_x) emissions from the oil sands and Cold Lake areas are not going to be entirely removed at source, these lakes will be in jeopardy, according to Dr. Allan Murray of the Fisheries division of the Department of Northern Saskatchewan Resources Branch.

So far, the lakes are all right, says Murray. But he predicts that within seven years the most susceptible ones (the very small lakes in certain locations) will reach a pH of 5.5. For others, the acidification process will take longer in some cases, fortunately, much longer.

A lake is a large, dilute bicarbonate solution. Carbon dioxide from the atmosphere and carbonate-rich material from the surrounding soils and bedrock dissolve into it, resulting in a bicarbonate-buffered solution. (Just as we say something is "buffered" from a drastic change, so a buffered solution is one that can withstand strong acid or base additions without undergoing much change in pH). The bicarbonate buffer keeps the lake's pH on an even keel and above pH 6, maintaining a healthy environment for plant and animal life.

Depending on how much carbonate-rich rock and soil is present in the drainage basin that feeds into a lake, its buffer system may be weak or strong. Strongly buffered lakes can neutralize greater amounts of acid than can weakly buffered ones. Thus, if acid is continually added, the weakly buffered lakes give out first. Their pH begins to fall more rapidly, in direct proportion to the amount of acid added. Large fluctuations in lake pH occur with each acid precipitation event.

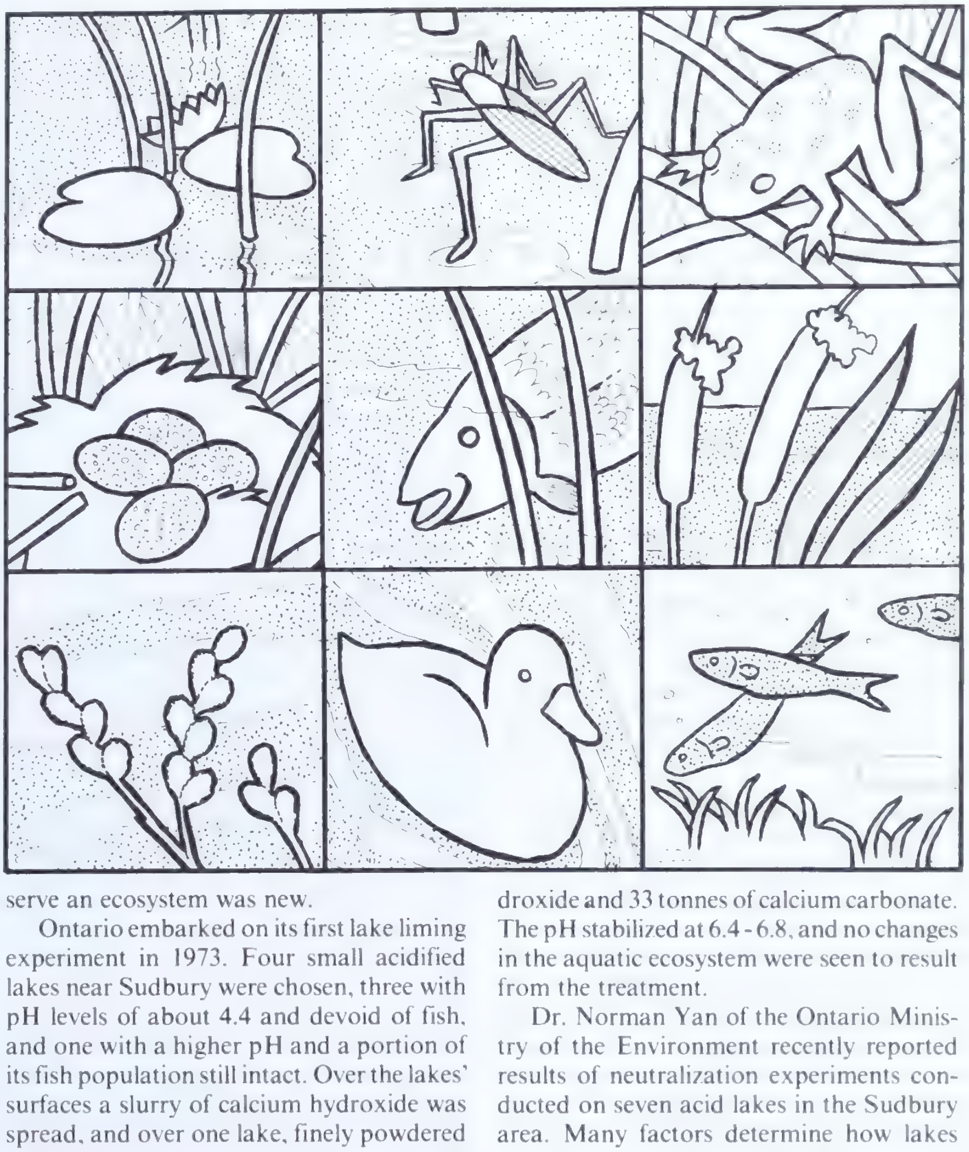
As the pH keeps falling, metals present in the bottom sediments and drainage basin soils become mobilized and dissolve into the water. At about pH 5.0, according to Dr. A. Henriksen of Norway, an aluminum-buffered system begins to function. But by then the water is so acidic that most if not all of the fish have perished and the entire aquatic ecosystem of the lake has been disrupted.

R.J. Beamish and Dr. Harold Harvey of the University of Toronto were among the first to document the demise of fish in acid lakes in Canada. As part of his graduate work, Beamish looked at George Lake in the LaCloche Mountains, 65 km downwind of Sudbury. Subjected to massive doses of SO_2 from Inco, the lakes upstream had already lost their sport fish, but George Lake had not. In 1966, five years after George Lake had begun an annual decline of 0.13 pH units, Beamish recorded the last successful lake trout reproduction at a lake pH of 5.5. Smallmouth bass were last reported taken in '65, walleye in '68 and burbot in '70. In 1971 Beamish observed that brown bullheads were failing to deposit their eggs. The pH was now fluctuating between 5.2 and 4.7. In '72 no pike, rock bass, pumpkinseed sunfish, or white suckers could be netted.

Spinal deformities and low blood calcium levels were found in the fish that were caught.

Since then, a number of reasons for the loss of fish in acid waters have been found, one being the inability of hatching fry to become released from their surrounding pro-

Canada's forests may face long-term damage from acid-rain



tective membrane at low pH. Another, responsible for the death of adult fish, is the coating of gills by aluminum at low pH; in response, the fish secrete so much mucus that they eventually suffocate.

While Beamish was studying fish, Scandinavian biologists were documenting changes in the macro- and microflora and fauna of acidifying Swedish lakes. A decline in species, as the acid-sensitive ones died off, was obvious. Snails and other molluscs disappeared. Most small algal species vanished while a few others took over. Many aquatic insect species disappeared.

At first, this whole process resulted in clearer, bluer waters, as the number of light-scattering algae decreased and certain substances precipitated. But gradually as acidification continued, a dense mat of fungus spread across the lake bottom. Leaves and other organic debris, no longer decomposed by bacteria, accumulated on the lake bottom. Layers of Sphagnum moss spread throughout the lakes.

Knowing that acid rain was not about to end - if anything, would increase - some researchers began to search for a quick fix, anything to alleviate the symptoms, temporarily or otherwise. "Is it possible to conserve our trout lakes through the next decades until the sources of acidification have been dealt with?" asked a Norwegian limnologist at an international conference on acid precipitation in 1980.

Sweden, having posed the same question earlier, apparently had found the answer: lime, added to several Swedish lakes in the 1960s, had restored the pH, and restocked rainbow trout, char and a supply of their favorite insects and gastropods were all holding steady a decade later.

Liming of water is not exactly a new technique: soda ash, dolomite, calcium hydroxide ("slaked lime") and calcium oxide -all falling under the general category of "lime" - as well as limestone, had been used to eliminate algae and solve other water quality problems (not acid rain-related) in farm ponds, water reservoirs and the like. But its large-scale use in an attempt to preserve an ecosystem was new.

Ontario embarked on its first lake liming experiment in 1973. Four small acidified lakes near Sudbury were chosen, three with pH levels of about 4.4 and devoid of fish, and one with a higher pH and a portion of its fish population still intact. Over the lakes' surfaces a slurry of calcium hydroxide was spread, and over one lake, finely powdered calcium carbonate was added as well. In all four lakes, the pH quickly rose to approximately 7; however, only in the lake given calcium carbonate did the pH remain neutral. The toxic levels of copper and nickel in the lakes dropped by about ninety percent. However, trout introduced into two of the fish-devoid lakes failed to survive.

Another lake with lower initial heavy metal concentrations in the same area was then treated with 50 tonnes of calcium hydroxide and 33 tonnes of calcium carbonate. The pH stabilized at 6.4 - 6.8, and no changes in the aquatic ecosystem were seen to result from the treatment.

Dr. Norman Yan of the Ontario Ministry of the Environment recently reported results of neutralization experiments conducted on seven acid lakes in the Sudbury area. Many factors determine how lakes respond to the addition of alkalizing agents, he told a recent seminar of Alberta Environment staff members.

In order to affect a change in pH, all components which absorb base have to be considered, such as the sediments (these can represent up to 30 per cent of a lake's "demand" for base), trace metals (30 to 40 per cent of total base demand) and free acids. If these demands are met, what is "left over" appears as residual alkalinity and an increase in pH is observed.

The resulting higher pH may remain relatively stable or slowly fall to its former acidic level, depending on the influence of several external and internal factors, and the addition of other chemicals.

In lakes where phosphorus was added, the pH remained relatively high, Dr. Yan reported. This was believed to be related to the release of basic byproducts from the plants' growth absorbing the phosphorus.

A tentative conclusion from these trials would seem to be that if the acidification process is discovered and treated at an early stage, a lake can be preserved. How often the treatment would have to be repeated is not yet known. But clearly, it will be costly.

The largest water liming experiment in the world is currently being conducted on the Hogvadsan River drainage system in southwestern Sweden. In an attempt to maintain the river's pH at a high enough level to sustain its failing salmon spawning grounds, the entire watershed is being limed: bogs, tributary streams, agricultural land, and lakes, at a cost of approximately $4 million over four years.

The amount of lime being applied is stupendous: lakes - 4 900 tonnes pumped from boats and trucks; streams - 1 600 tonnes of crushed limestone added directly into the water from two automated silos (one of which feeds it in according to the amount of streamflow and the other according to the pH downstream); farmland - 1 340 tonnes of powdered lime; bog land - 1 950 tonnes; and stream bottoms - 380 tonnes. If these additions still haven't brought the pH to an acceptable level (as happens sometimes during heavy acid rainfalls or snowmelt), additional lime is dumped directly into the Hogvadsan. Forty-two stations monitor the water chemistry monthly. By 1985, Sweden expects to be spending about $40 million annually on liming.

Nova Scotia has recently begun its own river liming program. According to Dr. W. Watt of the Department of Fisheries and Oceans, Environment Canada, twenty-two rivers in Nova Scotia have lost or are in the process of losing their Atlantic salmon populations due to acidity. Into one of these rivers, the Mersey, once a salmon spawning ground, limestone-filled cribs have been placed. Fry survival is greatly improved, as is overwintering by adults. In a tributary of the Mersey, bars of marble and dolomite chips are being placed on the stream bottom. Gravel made from marble is being laid directly on known spawning sites in other rivers in the province.

Is Saskatchewan prepared to rehabilitate its lakes if necessary? No, says Dr. Murray. In spite of the fact that northern Saskatchewan's recreational fishery, outfitting and tourist industry, and commercial fisheries will suffer, the number and size of lakes in the Shield area make liming and maintenance of fish hatcheries for restocking purposes out of the question. Acidification of lakes must be prevented before it begins.

For Saskatchewan, there is still some time; in Ontario, while the liming goes on, an estimated 2,000 - 4,000 lakes (at latest count) are becoming more acid.

Lime is being used for our SO_2 problems here in Alberta. Some of our soils are acidic (with a pH of less than 6.0) to begin with; some have become that way as a result of adding nitrogen as a fertilizer; and some have become acidic or have had their acidity increased by being near sour gas processing plants, oil well flares, or other SO_2-emitting sources.

Acid soils, from whatever cause, give reduced yields of most crops. As Adolph Goettel, head of Alberta Agriculture's soils branch, explains, two unrelated mechanisms are responsible for this. Aluminum and manganese, which become soluble as soils become acidic, are thought to be toxic to cereals and canola in particular. Alfalfa and sweet clover, on the other hand, do poorly in acid soils because of its inhibiting effect on the *Rhizobium* bacteria which live in the root nodules of these plants and fix nitrogen.

The average rate of lime application is 1.5 - 2.5 tonnes per acre. This will last for five to ten years. However, if the soil is as low as pH 5, 3.5 - 4 tonnes may be needed. For most crops, the soil should be about 6.5. By pH 5.5, alfalfa yield is down by 50 per cent and the yield of barley is poor.

But liming is costly. The calcium carbonate used to lime soils is a finely ground white powder, difficult to spread on the field without special equipment. At present the only processing facility is located at Exshaw, which means a 900 - 1 000 km haul for farmers in the Peace River - Grande Prairie area, where one-third of the province's acid soils are located.

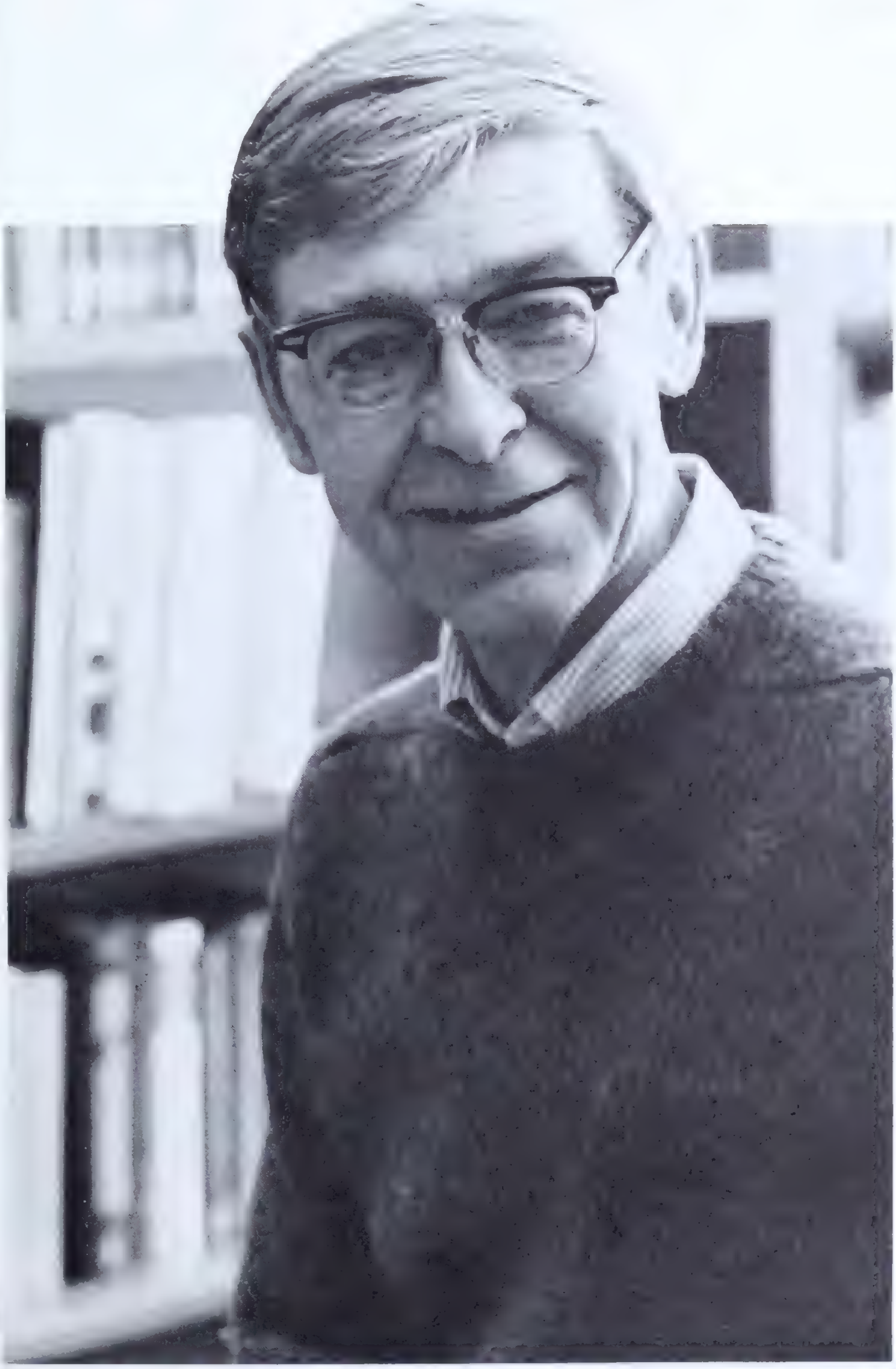
Under the Agricultural Lime Freight Assistance Program, eighty per cent of the freight over $5.50 per tonne of agricultural lime is paid from the quarry to the farm; this still leaves a cost of about $30 - 35 per tonne to be paid by the farmer.

It would be highly desirable if the costs were to be borne by the party responsible for the acidification: the farmer, in the case of acidification from fertilizer; or the petroleum industry, in the case of SO_2-induced acidity. At present, it is possible to estimate the contribution to soil acidity from each.

The amount of sulphur being added to the soil from SO_2 emissions is a topic currently under much debate. Dr. Marvin Nyborg of the University of Alberta soil sciences department estimates that up to 23 kg of S per .4 hectare per year may be deposited in the vicinity of a large SO_2 emitter. In the winter, he explains, our cold snow and ice hardly adsorbs any sulphur; it just blows off. But in the summer, bare soil can adsorb a great deal. The amount adsorbed falls off in a gradient that still shows some adsorption as far as 45 km away from the source.

Meteorologists and other soil scientists do not all agree with these figures. One reason for disagreement between soil scientists, points out Elston Solberg, a student of Nyborg, is that different ways of measuring soil sulphur have been employed.

Liming of forested land in the province has become necessary in a few localities in order to restore soil that has acidified from sulphur dust. Liquid sulphur, the result of H_2S removal from sour gas, is poured into giant blocks for storage. The dust arises



Tim Beer

Marvin Nyborg

when blocks are broken up for shipping. Soil bacteria oxidize the sulphur dust that settles on the soil into sulfate, and intense acidity results. Ways of avoiding this problem are currently under investigation.

Of broader import is the issue of whether the concentrations of SO_2 now being emitted in Alberta are affecting soils and vegetation. The Canadian Forestry Service, in conjunction with the industries involved, has set up 26 sampling sites near gas processing plants in the Rocky Mountain House area in the hope of answering this question. Hundreds of soil samples are now awaiting analysis.

Dr. Paul Addison of the Canadian Forest Service and director of the research project, says many replicates at each site are required because of the large inherent variability of soil pH. An earlier study which claimed to show a decrease of one pH unit near a gas plant was based on too few samples, he claims.

Are soils, and the forests on them, in other parts of the world endangered by acid precipitation? Sweden, the most "advanced" in field studies of this question, has so far found only a fertilizing effect from acid rain on tree growth.

But Bette Hileman, writing in a recent issue of Environmental Science and Technology, says reclamation of forest areas damaged by acid rain may call for application of fertilizers as well as lime, a proposal which is "quite impractical if not impossible" given the vast areas of forest which could be affected.

She describes the process: "Preliminary research results suggest that aluminum ions mobilized by acid rain kill some of the coniferous tree's feeder roots and as a result impair the tree's ability to take up an adequate amount of water and nutrients. Acid precipitation can also retard the decay of leaves and needles and thus the return of essential nutrients to the soil. Forest soils are especially endangered because they often have a low pH to begin with. Therefore a further loss of nutrients is significant, even if small in an absolute sense."

At some point, comments Dr. Gary Hogan of the Canadian Forestry Service, long-term detrimental effects on forest productivity can be expected to start showing up in Canada. But by that time, he adds, acid rain will have caused many other problems.

Lisa Fairweather is a freelance writer in Edmonton

Muriel Stringer

Emission Control Technology

New developments promise cleaner air — but at a price.

Acid rain may be the proof of Newton's law: what goes up must come down. But one way around this inevitability is to keep the ingredients of acid rain from going up in the first place.

Keeping pollutants from being released into the atmosphere can be accomplished at various points and by various means, depending on the nature of the operation producing the pollutant and upon the type of pollutant itself.

"Essentially, you're looking at two main categories of pollutants," explains Serge Dobko, head of the air quality branch of Alberta Environment's standards and approvals division. "One groups consists of particulates such as ash, dust, and any other small pieces of solid material. Often, you can actually see when this kind of pollutant is being put out. With the other major kind, you're more likely to go by the smell since this includes gases such as sulphur dioxide and hydrogen sulphide."

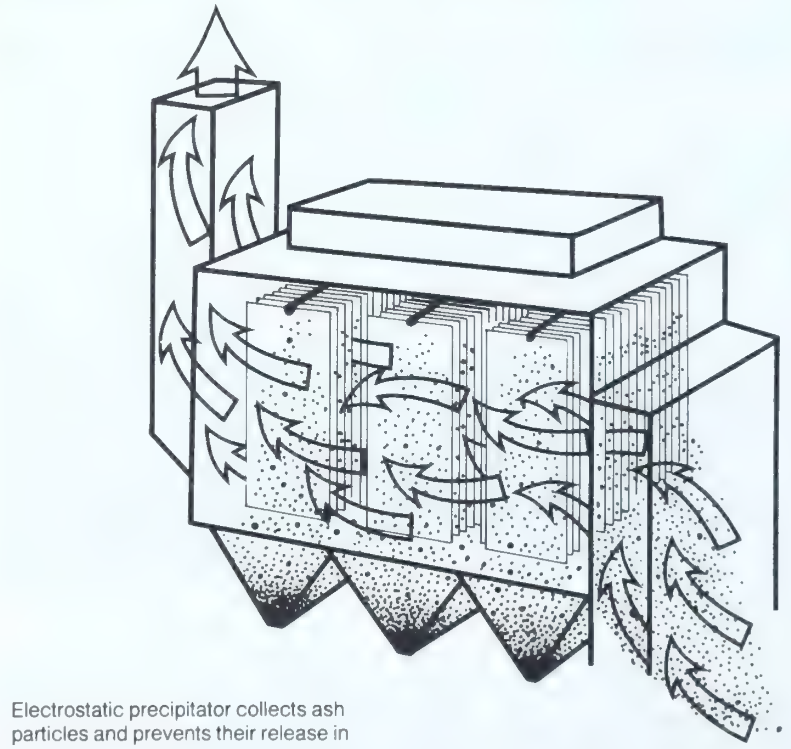
Carbon monoxide and oxides of nitrogen also fall within this second class although these are generally odorless.

Controls for gaseous emissions are primarily aimed at prevention of the release of sulphur dioxide, the major ingredient of acid rain, and methods currently used fall under two main headings - regenerative and non-regenerative.

A non-regenerative method is intended simply to make sure as little as possible of the gas gets out. Retrieving a useful by-product isn't a major concern.

With a regenerative system, on the other hand, recovery of a marketable commodity is one of the intentions, and in the case of sulphur dioxide, the product may be elemental sulphur or sulphuric acid. Sulphur-dioxide producers in Alberta, for example, are very much concerned with retaining sulphur, for which there has been a growing demand in recent years.

Dobko notes that, "There are a couple of methods of processing the gas in the so-called sulphur recovery plants attached to places such as Syncrude's tar sands operation at Mildred Lake. Both methods are



Electrostatic precipitator collects ash particles and prevents their release in atmosphere

Electrostatic precipitator at Alberta Power's plant

based on the same chemical reaction, though, and are in fact, just different variations on the Claus process. There's a reaction made to take place between hydrogen sulphide and sulphur dioxide to give liquid sulphur. The catalyst or chemical used to drive the reaction may differ but the fundamental principle is the same. Even the Scott process used by Shell's plant at Waterton is just an extension of the Claus system."

Over the past decade, objectives for sulphur dioxide control have become increasingly demanding and technologies have improved, largely through overcoming problems in the design of the equipment used and in the efficiency of the chemical reaction on which the recovery is based.

"'Scaling' or the plugging up of pipes with sulphur compounds used to be far more of a problem than it is now. Then, too, better ways of creating turbulence or mixing of the gases to give the reaction have helped give better pollution control."

For the large-scale sulphur dioxide emitter, recovery of sulphur may be an economic prospect but for operations such as smelters which put out the gas in a much more dilute form, production of sulphuric acid appears to be a much more viable option, according to Hugh Dibbs, senior technology control scientist with the air pollution control service of Environment Canada in Ottawa.

"There's no real incentive to install a complex recovery unit when the amounts of sulphur involved are relatively small. The sulphuric acid is a marketable product, though, so this is still a regenerative system".

Power plants, however, produce even lower concentrations and generally turn to non-regenerative or scrubbing systems to control their emissions.

"Here, it's a case of 'before' or 'during' rather than 'after'. The sulphur may be removed from the coal in part by crushing and washing it before combustion or the sulphur dioxide may be trapped by limestone scrubbing during combustion rather than doing something with it after it's been released. There isn't anything the power company can do about selling the sludge resulting from scrubbing, though, and in fact disposing of this material is a problem."

Acid gas emissions from smelters are also controlled in part by removal of some of the sulphur from the ore before processing. Pretreatment of coal with chemicals which leach or dissolve out some of its sulphur is another method of reducing sulphur before combustion.

But release of gaseous pollutants is a continuing and increasing concern, and in Alberta gas plants have historically been required to incorporate emission controls. Between 1971 and 1973, retrofitting or the addition of better control devices to existing operations was carefully scrutinized but only the larger gas plants were required to upgrade.

Dobko explains, "We expected the older plants to have a natural upgrading cycle, anyway. When they renovate or expand, they have to meet the new objectives. We felt that the cost of retrofitting say, eight small plants, wouldn't be justified. The payoff in reduced emissions by having a big operation such as Amoco's Crossfield plant retrofit was likely to be a good deal more."

Cost effectiveness, he admits, is hard to measure when the cost to society of inefficient controls is taken into consideration. These are diverse and impossible to measure in dollars and cents.

"The most we can do is to make sure each operation installs the best practicable technology. There's no one 'right' answer to pollution control. Each system has its advantages and disadvantages and the choice is governed by the type of plant you're dealing with, the material it's processing, and sometimes even by its location."

In Canada as a whole, the two largest sources of sulphur dioxide are coal - burning thermal power plants and non-ferrous smelters such as Noranda's copper-processing operation at Rouyn-Noranda in Quebec and the International Nickel Company's plant at Sudbury, Ontario.

Out west, though, most of the sulphur dioxide and hydrogen sulphide, are put out by sour gas refineries and plants.

Coal combustion is not a major source of sulphur dioxide in Alberta since most of the coal used in power plants is sweet and has a very low sulphur content. This contrasts with much of eastern Canada where the sulphur content of the sulphur content ranges from 2 per cent to 4 per cent and where the acid gas problem from its use is potentially greater.

Overall, about half the nitrogen oxide emissions in Canada are also from coal-fired power stations and other industrial sources but in Alberta gas processing plants constitute the single largest contributor, with emissions in 1979, for example, of 132 000 tonnes. While it is usual to regard industry as the main culprit, the general public must accept some of the blame for the release of nitrogen gases. Automobile emissions make up a high proportion of the remaining half of the total load which also includes exhaust emissions from other forms of transportation and oxides formed by the combustion of natural gas in home heating systems.

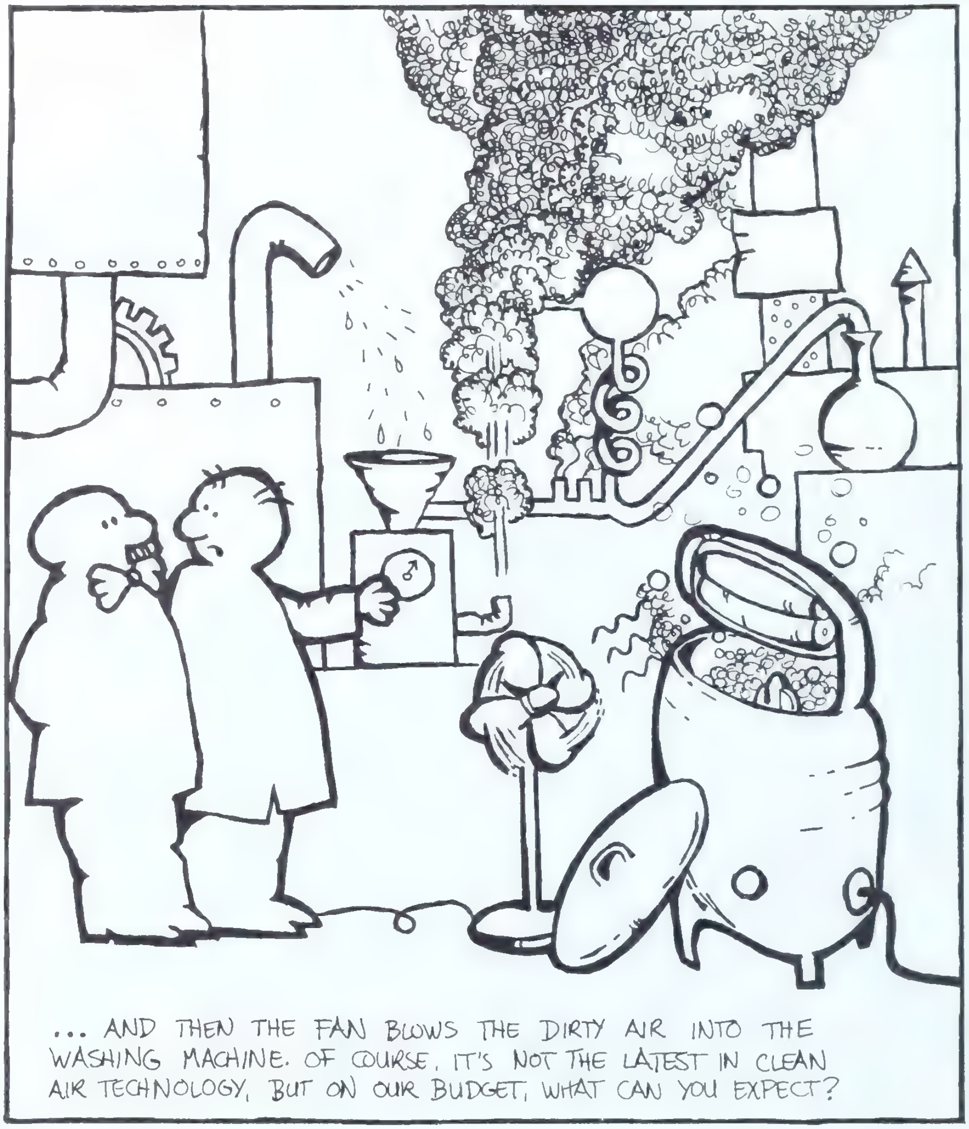
Controls for nitrogen oxides, Dobko explains, are based on prevention rather than cure.

'It's a case of trying to allow as little as possible of the gas to form rather than using some device to catch it once it has been produced. Most of the attempts to reduce releases are based on 'combustion modification', the idea being that the lower the combustion temperature, the less the nitrogen oxide formed."

Another method, as yet used only in Japan, is described by Dr. Dibbs.

"Here, the oxides of nitrogen are reduced or broken down to nitrogen and water, which are both relatively harmless products. While we're not using this method in Canada so far, I think it could be considered for processes where it simply isn't feasible to reduce combustion temperatures to a level where nitrogen oxide formation is significantly affected."

In the case of automobiles, design changes have helped cut down the release of nitrogen gas emissions as well as other pollutants resulting from gasoline combustion.


... AND THEN THE FAN BLOWS THE DIRTY AIR INTO THE WASHING MACHINE. OF COURSE, IT'S NOT THE LATEST IN CLEAN AIR TECHNOLOGY, BUT ON OUR BUDGET, WHAT CAN YOU EXPECT?

"Since about 1973, Canada Transport has placed limits on the permissable amounts of exhaust emissions," says Dobko. "This has led to developments such as the catalytic muffler which converts carbon monoxide to oxidized forms, and to various changes in engine design aimed at reducing nitrogen oxides."

While not all particulate matter contributes to which can be loosely termed "acid rain"; the control of the release of particulate matter has improved over the years and will be increasingly important in reversing the steady decrease in air quality which has occurred in recent decades in North America.

In Alberta, main producers of particulate matter are coal-fired power plants and asphalt and cement manufacturers. However, according to Dobko, "Any operation which uses a boiler with solid fuel will emit particulates. Pulp mills, for instance, burn off waste bark in boilers."

Wood-burning fireplaces are also becoming increasingly common in new housing developments and collectively can make a significant contribution to the particulate load.

With particulates, catching the suspended material before it can escape to the atmosphere is the basic objective.

Dobko outlines four basic methods: "First, there are electrostatic precipitators which operate through a series of electrically charged plates. These attract the pieces of solid material from the air passing between them. Periodically, the accumulated solids are simply knocked off the plates in hoppers beneath. Typically, you'll find electrostatic precipitators in thermal power plants and oil sands operations."

An up-to-date modification on electrostatic control was recently installed by Alberta Power in its Battle River plant. Here, for the first time in North America a "dense-phase" system is used to transport the particulates or fly-ash. Normally, the ash is blown from the hoppers through expensive, abrasion-resistant piping to holding bins. At the Battle River station, the ash is put under pressure and squeezed through narrower, much cheaper piping.

Costs are also reduced by Alberta Power's active marketing program which has encouraged the use of the ash in reclamation work and, more recently, in making particularly strong concrete for dam building.

An older and somewhat less sophisticated method of filtering out dust and ash is the bag house. Made of nylon, fibreglass, or felt, a bag house is merely a large sock which acts as a sieve over an outlet where particulates might be released. Feed mills often employ this system but its use is limited elsewhere by its inability to withstand very high temperatures. Sometimes, however, it may be the only feasible option, as in the case of the H.R. Milner power plant near Grande Cashe where the fly-ash proved very difficult to capture by electrostatic precipitation.

A third possibility is the cyclone system which is based on the same principle as a centrifuge. The particles are spun out by centrifugal force when the air is rotated very quickly.

Also based on the forced movement of air is the Venturi scrubber. In this case, the gases with their burden of particulates are forced through a system of narrow tubes into which water is sprayed. Large fragments of solids are trapped on the water surface and in turn act as centres where smaller particles accumulate.

While some research is being done on improving electrostatic precipitators, Dobko believes that there are no really new methods being devised.

"Anything that does come along is just some variation on one of these four main concepts."

Mobile asphalt plants, for instance, frequently have to use bag houses instead of the more commonly employed Venturi scrubber best suited to this type of operation.

"They're often set up in places where there's not enough water so the Venturi system is out of the question. When it comes to deciding which control method to use, though, each case has to be dealt with individually. Dollar cost is one consideration but there are a great many other factors that have to be taken into account as well."

Muriel Stringer is a freelance writer in Edmonton.

Muriel Stringer

Marketing Sulphur

Profiting from pollution control.

Sulphur train loading near Rocky Mountain House

While sulphur gases may be looked on as an undesirable addition to the atmosphere, sulphur itself is one of Canada's most important exports and has, in recent years, found an increasingly favorable market throughout the world.

"Most of the sulphur used commercially is first converted to sulphuric acid. About 60 per cent of all sulphur is used in making fertilizers," explains Jim Hyne, professor of chemistry at the University of Calgary and Director of Alberta Sulphur Research Ltd. "Another 20 per cent goes into the chemical industry and the remaining 20 per cent is used in a variety of operations such as pulp and paper, textiles, and paint manufacturing."

In supplying other nations with sulphur, Canada's western provinces are the world leaders, with Alberta the prime source. Only Poland comes near our production but, as Professor Hyne puts it, "we're ahead by a country mile."

Until the last few years, however, supply exceeded demand, and it was only in the late 1970s that world markets became large enough to absorb the quantities Canada could provide. In the early 1950s, annual production in this country was around .5 million tonnes. Twenty years later, it had risen to some seven million tonnes a year, due mainly to the expansion of the sour gas industry.

"The population of the world rose rapidly over that period, too," points out Dr. Hyne, "And with it the need for food. This in turn gave rise to greater agricultural activity and to the need for more fertilizer. But the resulting demand for sulphur didn't increase as fast as we were producing it through our burgeoning sour gas operations. It was only in the last few years that demand caught up with and actually exceeded supply."

A boost to Canada's marketing of sulphur also came in the late 70s with the formation of SOLTRAN, a company created to handle the shipping of sulphur to suitable sites for export.

Don Muir, president of the Sulphur Development Institute of Canada (SUDIC) notes that shipping problems at one time significantly limited offshore sales.

"But now most of the sulphur going overseas is routed through Vancouver. Material going abroad is in the form of pellets or slabs while it may be transported in liquid form within North America itself. As far as the actual marketing goes, most sulphur producers in Canada have their transactions done through another consortium type of company called Cansulex. Both SOLTRAN and Cansulex have done a lot to promote our sales outside the country."

Before demand reached its present level, however, stockpiling was common practice and today Canada still has a fairly large reserve although this is being steadily diminished.

"We're producing over seven million tonnes a year," Hyne estimates, "But the market is eating into our inventory. In 1979, we had 21 million tonnes on hand in Canada. Now it's down to 16 million."

From the producer's point of view, sales prospects remain attractive although prices did weaken in the last quarter of 1981, acording to Don Smith public affairs manager for Amoco.

"I don't think it's the market or even the availability of better technology that's necessarily causing any increase in recovery of sulphur, though. We're required to keep down our emissions anyway so in a sense the sulphur is just a by-product."

It is, nevertheless, an important and lucrative enough spin-off of the oil and gas industry that SUDIC was formed to foster sulphur sales, partly by researching new uses.

"We've come up with two that look especially promising," says Don Muir. "Sulphur can be used to extend or dilute asphalt - this gives a more durable road surface in some parts of the world, as well as a cheaper material. And we've devised a sulphur cement which can, in some situations, replace Portland cement. It's very resistant to acid and salt and has been used, for example, in a smelting operation Trail, B.C."

But the main market seems likely to remain the preparation of fertilizers and in a paper presented in Kingston in February Professor Hyne emphasized the crucial role Canada plays in maintaining supplies.

"Sulphur dioxide shouldn't be looked on just as a pollutant, as many environmentalists tend to do. If we simply tried to get rid of it without recovering the sulphur, the impact on world supplies of sulphur would be such that millions of people would starve to death."

Jack Spearman

Researching the Rain

An interdisciplinary approach is what's needed.

Dr. Harby Sandhu

Scientists agree that acid precipitation — in the form of rain, snowfall or dry deposition — does not yet pose a wide-ranging environmental problem in Alberta.

But in the next breath, they invariably warn against complacency. Acid depositions are a byproduct of industrialization and the potential for problems will grow hand-in-hand with the expansion of the sulpur - and nitrogen - emitting petrochemical industry.

Dr. Harby Sandhu, Alberta Environment's senior research manager and co-ordinator of acid rain research, notes that because the problem is still in its early stages in the province, there's a chance to practise some preventive medicine.

"The time for action is now," he says. "We have the opportunity to be proactive rather than reactive . . . but we have a lot to do yet so we can get some early warning systems into effect.

" . . . Quite simply, when acid rain comes down into the eco-system, what happens? How does it affect the soils, what happens to forest growth, to animals and to humans?"

Acid rain is not a new problem, although it has been taken seriously in North America just in the past few years. (Alberta, for example didn't open its string of monitoring stations until April of 1978.) Even basic research is incomplete.

Here's what the parliamentary subcommittee on acid rain, in its report entitled "Still Waters" had to say about the situation:

"What is lacking . . . is a detailed body of data on historical trends in acid deposition, a comprehensive overview . . . and a precise quantitative assessment of acid rain damage and rates of acidification in areas of differing sensitivity.

"With 12 networks in place in Canada . . . the potential difficulties that could ac- from disparate monitoring standards are obvious . . . Of particular importance is the need for standardized methodology to permit ready comparison of results obtained by various monitoring systems operating in Canada."

Most of the sulphur dioxide emitted annually in Alberta come from gas processing and oil sands plants. Almost a decade ago, 17 of the major energy companies (among them household names such as Amoco, BP, Esso, Gulf Canada, Husky, Petro Canada, Syncrude and Texaco) formed the Oil Sands Environmental Study Group (OSESG), pledged to "the protection of the environment in both the long and short term, with respect to the development of the Alberta oil sands". OSESG also claims "a leadership role in conceiving, developing and implementing research programs."

OSESG says Albertns don't need to worry about acid rain here — yet.

OSESG does have a 50-year acid rain measurement plan under way, however, to computer-plot airborne pollutants from the oil sands areas of Athabasca, Wabasca, Peace River and Cold Lake.

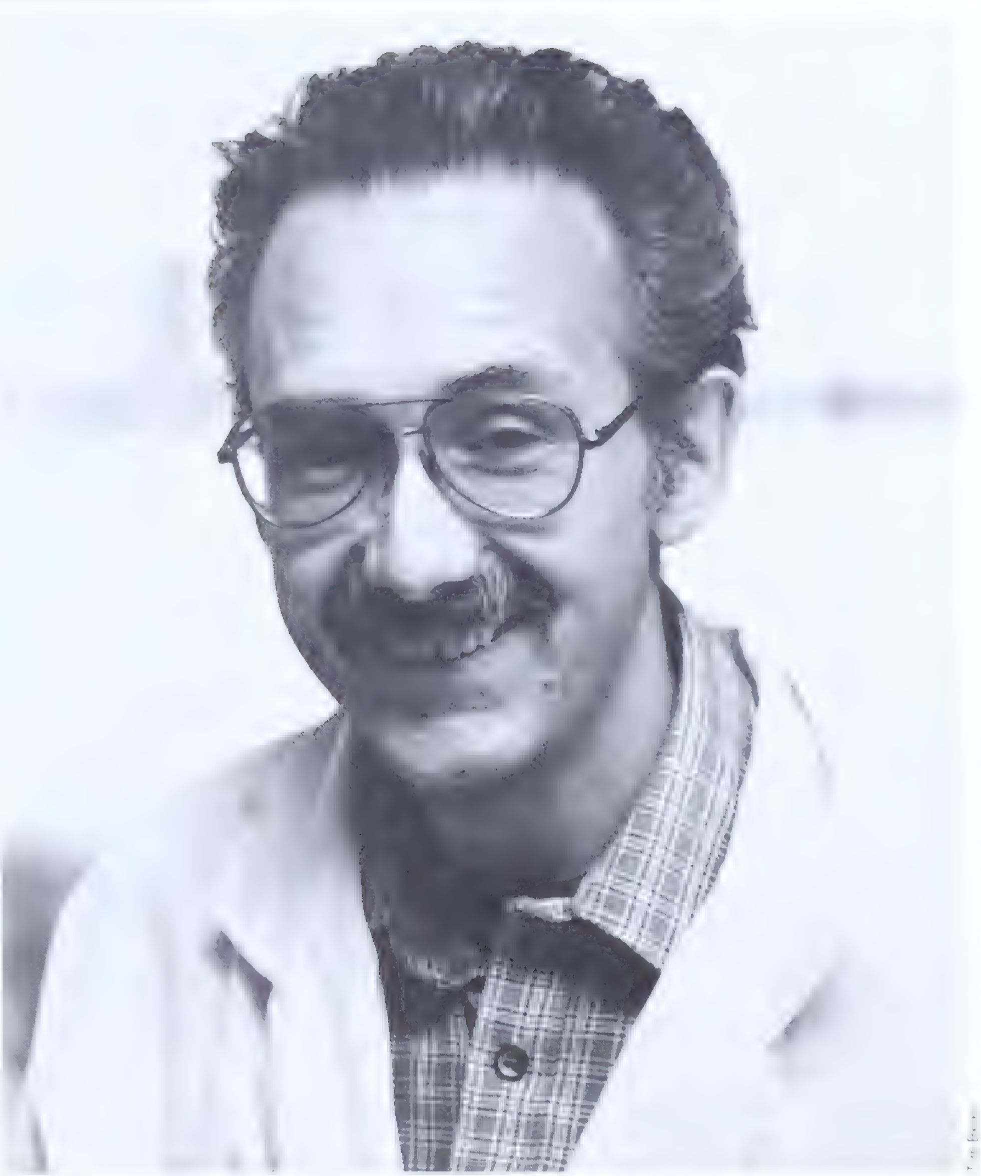
This data, an OSESG spokesman told the federal acid rain subcommittee, "will enable us to put into perspective the significance of the sands developments with respect to any long term effects on the environment associated with emissions into the atmosphere."

Sandhu cites the need for both short-term and long-range research into acid depositions. He gives the example of the pH level in a lake. In fairly short order one can determine the acidity of the lake but it would take years longer to determine how those levels would affect plant life in the lake, fish, lakeside vegetation and nearby wildlife. And from that single lake, how about the rest of watershed?

Dr. Marvin Nyborg of the University of points out that there has been very little done on the effects of acid deposition on the most basic resource of all. "But it's really not that simple to monitor; there just isn't a gadget you can plug in," he adds.

Acid rain's impact on soils in Alberta is inconsequential" says Nyborg. But dry deposition of sulphur dioxide — one of the precursors acid rain — from sour gas plants in the province is a different matter.

"We do know there's a lot of SO_2 that



Dr. George Shaw

falls down and is absorbed in the general vicinity of the plants, a local problem within about 20 miles . . . we're talking about fairly large amounts in the range of 25 to 50 kilos per hectare annually."

But in all the excitement over acid rain, dry depositions have gone largely unstudied. As the federal subcommittee wrote:

"Some scientists estimate that 10 to 30 per cent of the acid deposition problem may result from dry deposition . . . we believe this is a component of acid precipitation that is sufficiently important to justify a major and continuing research effort."

Nyborg agrees. "This is a burning question . . . what happens to SO_2 when it reacts with the soil? One should be able to predict what would happen but we just don't have enough informatin at this stage to make those predictions," the soil scientist adds.

The province meanwhile has commissioned a private consulting firm to address dry depositions and to prepare recommendations on such basic questions as how to collect samples.

One question on acid depositions that is being researched in two different projects is the relationship between sulphur and selenium deficiencies in cattle and certain species of hooved wildlife. A selenium deficiency is known to cause sickly animals, and stillbirths in severe cases or even death.

Rocky Mountain House veterinarian Dr. Martha Kostuch has noticed increased infertility, calving problems and uterine infections in central Alberta dairy herds. Selenium and sulphur are chemical cousins and she began to wonder if excess sulphur were not competing with selenium for absorption by the animals. The two chemicals are interchangable.

"I used to practise in Minnesota on similar herds and there were no problems," she says. Since moving to Rocky in the mid '70s, she says she's seen every cow in some herds displaying symptoms.

There are two gas plants close to Rocky Mountain House. The Canterra plant about 35 kilometres southwest of town is the province's largest single producer of sulphur emissions after the oil sand plants.

Her concerns sparked a study by the Alberta Environmental Centre at Vegreville.

"This is an extremely complex problem," says Mike Prior, head of the centre's toxicology group. "It may be caused by very subtle interactions from a number of variables."

Data is still being collected and it will probably take another two or three years to get a definitive answer, he says. "At this stage, after just one year, the figures we have are too preliminary . . . we just can't give a yes or a no answer yet."

A related study is being conducted by the Canadian Wildlife Service, says wildlife toxicologist Dr. George Shaw. It too is still incomplete.

It was a similar sounding problem with elk and deer at calving time that prompted the probe. "We do know that there is a mortality rate, especially at calving . . . no has been assigned and there could be several . . . but it is possible that this question of selenium and sulphur could compound it."

The CWS study looks at chemical components in plants to see if SO_2 can cause reductions various elements in the plant, including selenium. The results are then carried forward into the animals that browse upon them.

Among the variables to be sorted out, Shaw says, is the fact that forest soils are often naturally low on selenium.

Sandhu is Alberta's representative on a committee with members from the other western provinces looking into acid rain research and monitoring. One of the goals of the Western Canada Long Range Transport of Atmospheric Pollutants' technical committee, he says, is to keep member provinces abreast of research in other provinces and to avoid duplication of effort and costs.

Meanwhile in Alberta, the Steering Committee on Acid Gas in the Environment has drawn on the expertise of 50 scientists from industry and government to prepare a set of recommendations on a research program.

Joe Godden with acid precipitation samplers.

The report is currently under consideration at the political level.

Alberta now operates six monitoring stations, from Beaverlodge and Whitecourt in the north, in Edmonton and Red Deer and south to Calgary and Suffield. The samplers consist of two buckets and one lid, operated by an electric motor which leaves one bucket exposed depending on the weather. Every month, the samples are collected and sent to Vegreville.

The federal government operates five monitoring stations in Alberta, at Fort McMurray, Edson, Rocky Mountain House, Coronation and Lethbridge — part of the CANSAP (Canadian Network for Sampling Precipitation) network that operates 56 stations from coast to coast.

As this magazine went to press, acid rain scientists were converging on Edmonton for a symposium entitled Acid-Forming Emissions in Alberta and their Ecological Effects, an event co-sponsored by Sandhu's research management division, OSESG and the Canadian Petroleum Association. With this three-day information exchange, says Sandhu with the hint of a sigh, "we'll know what the hell we know and don't know."

One research paper that is bound to attract interest at the symposium will be presented by Dr. H.R. Krouse of the department of physics at the Univesity of Calgary. His work with sulphur isotopes in soil could make it possible to identify sulphur-polluting sources beyond doubt and perhaps even provide the first-ever accurate measurements of man-created sulphur in the province's soil.

Speculation about Krouse's findings has been making the rounds of environmentalists for months.

Judy Roschlaub of the Peace Country Acid Soils Commission believes Krouse's work will finally provide hard scientific evidence to link sulphur emissions with dry-deposition (as opposed to airborne acid rain) acidification of the soil of the Peace country.

"Projections for gas plants are very high," says Roschlaub, who, with her husband, farms almost 400 hectares near Debolt, holds a B.Sc in pharmacy from the University of Alberta and is a prime mover behind the district's eight year old, volunteer information-gathering acid soils commission. Its purpose? "To bring to the attention of the decision-makers those soils most sensitive to emissions."

It keeps the small group busy. At Silver Valley, also in the Peace country, farmers are protesting the construction of a gas plant, and the group keeps a close eye on research into emissions affecting their sensitive region.

"We've won battles, but we haven't won the war," she says, pointing to the commission's biggest achievement so far - managing to get a gas plant which had been burning off its natural gas for 25 years to start piping the gas to Valleyview.

Dr. Allan Legge of the University of Calgary's Kananaskis Centre for Environmental Research, sees tackling of the acid deposition problem as one that may require almost a new breed of researcher.

The problem is inter-disciplinary, stretching into virtually every corner of science. But universities turn out scientists who are highly specialized, whose points of view are narrow.

To come to grips with acid depositions, a biologist will have to know chemistry and a physicist will need to know toxicology. "We will need people with a broader knowledge base or at least one scientist who can make himself understood to a specialist in another field."

He also notes another problem with finding qualified people. In terms of acid rain, the action is in the east.

With funding, the question leaves the hands of scientists and goes to the politicians.

"Generally, funding for monitoring is adequate," said Legge. "They could always do more . . . "Lots of money is needed," he added, explaining that a properly equipped trailer full of ambient air monitoring equipment costs about $150,000, excluding the costs of staff.

Long term research projects, which often require researchers and support staff to probe a problem for years on end, is even more expensive and there are no assurances of answers at the other end. That can be a problem to a government handing out research grants.

Legge says government needs to know the bottom line — it wants researchers to provide information on which policy can be based.

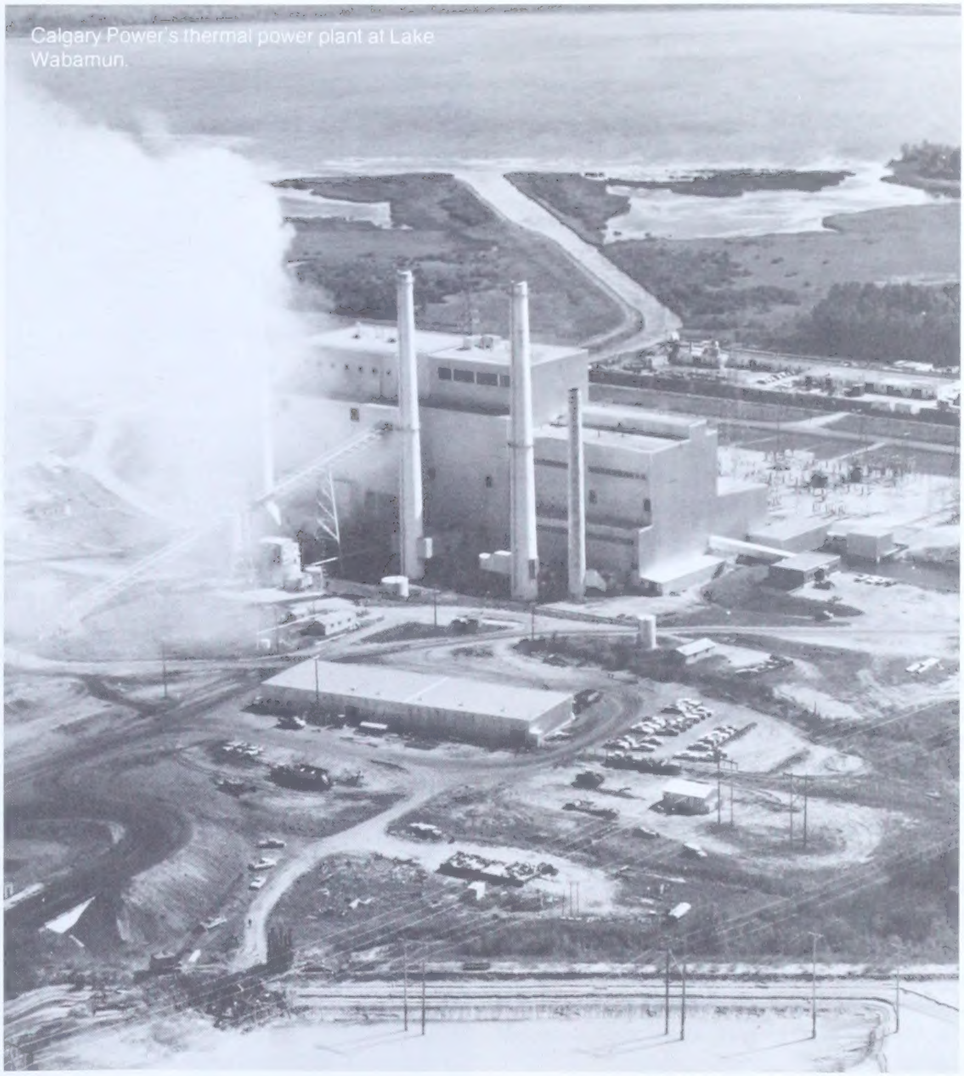
"It just doesn't work that way. It can't always be done, or at least not in the time they want it in."

Jack Spearman is a Calgary journalist.

Norma Ramage

The Corporate Nightmare

Telling industry's side of the story.



Calgary Power's thermal power plant at Lake Wabamun.

Alberta Government Photo

Acid rain is a dirty term in the plush corporate offices of the Alberta oil patch.

The sound of the words has been known to make a $100,000-a-year oil company executive blanch. There's no doubt, acid rain is a sensitive subject among the people so often accused of causing it - the oil and utility companies.

It's such a sensitive subject that some corporate officials contacted by Environment Views simply declined to discuss it. Those who did agree to talk to the magazine had one thing in common - they were tired, they said, of being unfairly labelled as corporate villains.

"The whole story isn't coming out. It's been blown out of proportion in the media," said Ron Finley, a spokesman for the Canadian Petroleum Association.

Finley, a biologist with Amoco and one of the people who prepared CPA's brief to the federal subcommittee reporting on acid rain, is afraid the public is hearing only one side of the acid rain issue. They're hearing a nightmarish scenario of dying lakes and polluted air, a scenario many people in industry say isn't likely to become reality in Alberta What they don't hear about, however, is industry's attempts to come to grips with and solve the problems of acid rain-causing emissions.

Nobody, said Finley, knows about the millions of dollars industry is already spending to control sulphur and nitrogen pollutants or of the further millions they're spending on research projects to find ways of dealing more effectively with the problem in the future.

"Anytime we try to present our side, somebody takes the words out of context. The industrial scene, what we are doing, is boring and mundane and it doesn't sell newspapers, so it's never heard about."

Industry's view of the acid rain problem hinges on three points: that the problem of acid rain isn't as severe and immediate as the public is led to believe; that industry is already in the forefront of the battle to understand and control it; and finally, that the bottom line which the public must deal with is that there is a price, and a high one, to be paid for total control of sulphur and nitrogen emissions.

The first point that industry spokesmen make is that the situation in Ontario with its dead lakes and the lunar landscape of Sudburn, just isn't going to happen in Alberta. The soil and water here is much more alkaline and consequently, more resistant to acid-forming reactions. The Devonian limestone, on which most of Alberta rests, is a naturally buffered area and even if the acidity of precipitation increases, environmental effects will still be minimal.

So it's not surprising that a lot of industry spokesmen are bitter over what they see as a blatant appeal to the darker fears of the public, an attempt to compare the oranges of Ontario with the apples of Alberta.

"So far we're not seeing any environmental damage from acid rain in Alberta," said Finley.

He points out that Still Waters, the sub committee's report on acid rain problems in Canada concluded: "The Alberta environment is not, at present, suffering measurable damage from acid rain."

The people in Alberta's resource industries are tired of being tarred with the same brush as Ontario industry when the situation here is entirely different, explains Cliff Paulson, vice-president for gas with Shell Canada Resources Ltd.

"It's easy for the federal government to turn to Alberta and talk about acid rain controls rather than going to Ontario and raising Cain with two million voters," Paulson says.

"It's easy to turn to Alberta, to drag in the Heritage Trust Fund, the nice, rich oil companies and the big multi-nationals. They're all easy targets."

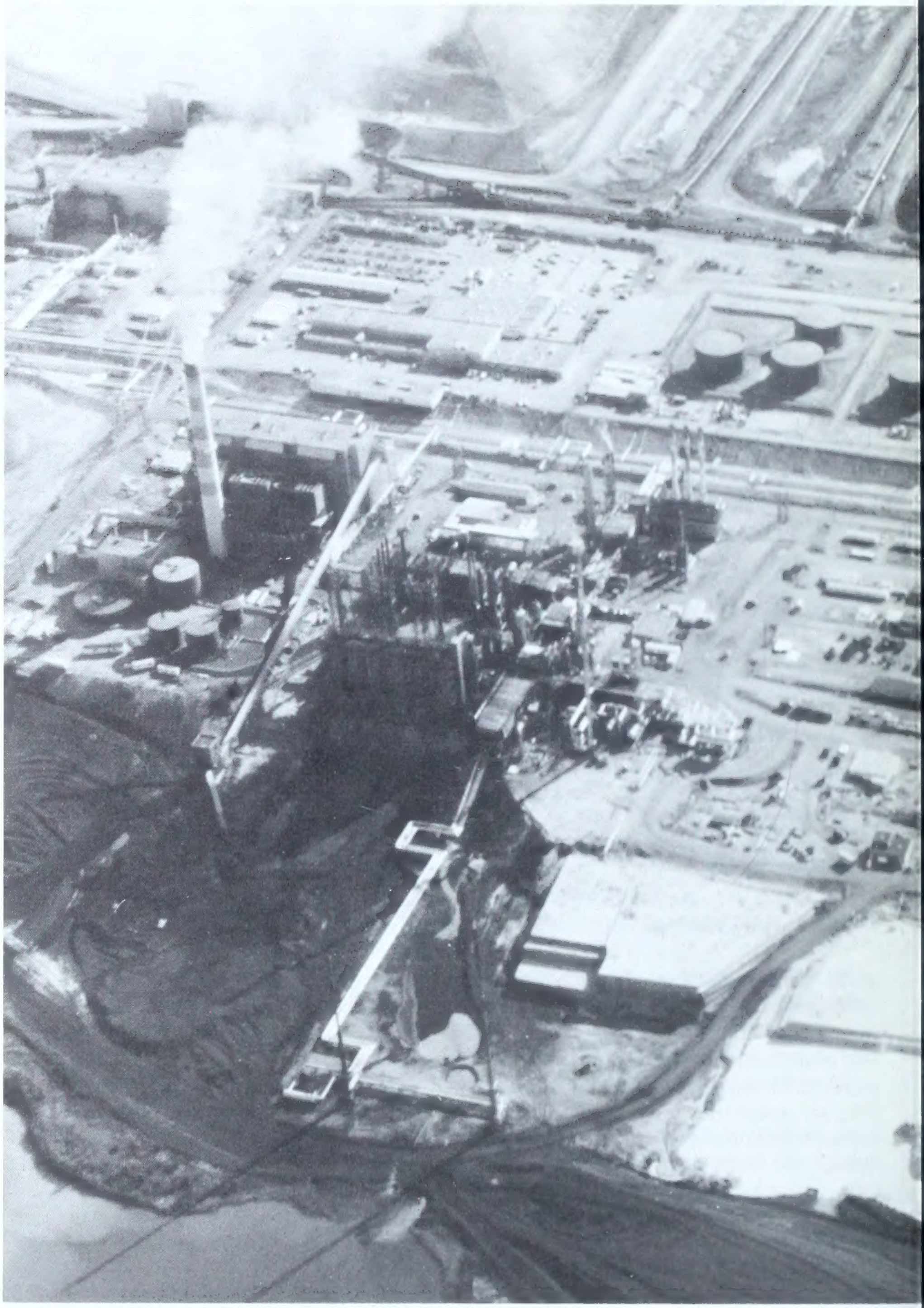
Alberta's utility companies, too, are quick to point out the differences between their operations and the often-cited polluting activities of their eastern counterparts.

Dick Way, a spokesman for the Electric Utilities Planning Council, which represents the companies owning and operating the province's four coal-burning power plants, says there is a vast difference between the type of coal burned here in Alberta and that used in other parts of Canada.

"The coal we use has about a .2 per cent sulphur content," explains Way.

"In New Brunswick, I've heard that some plants use coal with a sulphur content as

Suncor plant near Fort McMurray.



high as eight per cent while in Ontario, most coal used in thermal plants has between two and four per cent sulphur content."

"There's a lot of emotionalism involved with the acid rain question and people don't see it clearly," says Finley.

The only way to see the problem clearly and objectively is to go out and gather a lot more hard scientific data than is currently available, says Ron Wallace, chairman of the Oil Sands Environmental Study Group, a research organization funded by 17 different oil companies.

"From the data available now, it appears there are no attributable effects to acid rain produced in Alberta," says Wallace.

"But the whole matter can't be resolved properly until we have more information to go on and it is the resource industry that is in the forefront of efforts to get that kind of statistical data."

Wallace was involved in one of the first Canadian studies of acid rain in Kenora, Ontario, in 1975. He points not only to studies done by OSESG but also to projects like Amoco's massive study of emission effects in the Whitecourt area and to the fact that Syncrude "led the pack in industry with a huge environmental research department back in the seventies."

"That has to speak for something, to show that we're concerned corporate citizens," says Wallace.

Industry spokesmen also say frankly they're hesitant to commit the multi-millions of dollars necessary for emission controls until there is reliable data to show there is a problem.

"If you asked me whether right now I think the situation warrants the kind of expense we would have to talk about, I'd have to honestly say that no, it doesn't, not yet, not as far as we know," says Paulson.

John Curry, vice-president of Canterra Resources, wonders just how much of the responsibility for research lies with the oil companies.

"Industry won't resent controls if it is proved to them there is a problem. But I wonder whether we should be the ones who have to go and do the finding out. Maybe we would be more encouraged if the government gave us some financial aid such as tax incentives."

Says Finley: "We don't have the data right now to decide whether to clean it up or not."

But, he adds quickly, "That doesn't mean we're sitting on our laurels because we don't see a problem here now. We're checking on what's happening all the time. We're admitting any pollutant can cause a problem and we want to make sure those problems don't happen."

And Finley is also quick to point to industry's already-impressive record in emission control. The CPA notes that "from 1974 to 1978, despite an increase in the number of emission locations from 60 to 71, the actual tonnage of sulphur emitted from gas plants decreased from 673 tonnes per day to 446.8 tonnes per day, a reduction of 29.9 per cent."

Spokesmen for the oil sands companies talk of major new strides in emission control equipment, strides that mean the Syncrude plant produces only 27 per cent as much sulphur per unit production as the Suncor plant, built 11 years earlier. And the proposed Alsands plant would emit only 66 per cent of the sulphur coming from Syncrude.

Spokesmen for the oil and gas compan-

Alberta Government Photo

ies are proud of their record in emission control and proud of the fact they can live up to Alberta's emission control regulations which are the most stringent on the continent.

"On average in Alberta, our gas plants have about a 97.3 per cent emission control rate compared with an average of about 65 per cent in Ontario," says Finley.

"We're not fighting these standards, we agree with them and everywhere, the trend in the industry is toward lowering emissions."

But lowering emissions is a phenomenally costly business. For example, to go from 95 to 97 per cent control of emissions from a gas plant costs about $55 million, says Finley. But to move just another .4 per cent to 97.4 requires another half billion dollars. It's a logarithmic progression with the costs multiplying dramatically to inch up those last few percentage points to 100 per cent control.

Then there's the energy cost of running the emission controls themselves. The CPA estimates it could take the output of one small gas field to run all the emission control mechanisms in the province for just one year.

And the story is much the same with utility power plants. If anything, says Way, it's an even more expensive proposition for utility companies than it is for gas plants.

"The reason is that we're going after a very dilute pollutant, perhaps .02 per cent compared with 28 per cent for a sour gas plant. It can cost five to 10 times as much money to put controls on a power plant as it does to put them on a sour gas plant."

It would cost $42 million to put scrubbers in a power plant the size of Sundance, says Way, as well as an additional $7 million a year in extra operating costs. That would mean every new plant equipped with scrubbers would cost 25 per cent more to build and these costs would inevitably be passed on to Alberta consumers.

This added cost is the bottom line that Albertans will have to face, says Finley: not only the direct costs of producing a more expensive product but also the indirect costs from a damaged economy.

While nobody was willing to say that their company would move out of Alberta if the government pressured them into 100 per cent emission controls, it's obvious that some economically sensitive areas of industry might not be able to take the added cost. For example, with the Alsands project already reeling from the withdrawal of two major partners because of a projected inadequate profit margin, it would be hard to blame the provincial government for being unwilling to add the extra financial burden of expensive emission control technology. Curry says it may not be simply a matter of passing on costs to consumers.

"We're like a utility right now, with the government setting our prices. The lid is on tight and we have to make our profits based on economies we make from within. Expensive emission controls just mean the lid is on tighter."

"When you talk about the economics of emission control, you're really talking about how much you, as the consumer, are willing to pay," says Finley.

"It's whatever the taxpayers see as a fair return. What kind of environment do they want and what are they willing to pay for it?"

Norma Ramage is a Calgary journalist.

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Environment Update

Fort MacKay Health Study

The 300 Indian and Metis residents of Fort MacKay are understandably distressed about their awesome industrial neighbors.

Their community, 60 kilometres north of Fort McMurray, is at the centre of major oil sands development, including the existing Syncrude and Suncor oil sands plants and the new Alsands and Canstar projects.

A major federal health investigation now underway could put their fears to rest — or give them statistical ammunition for tougher pollution controls.

It is the second major study of a Canadian industry's impact on the health of native people. Like the study of the Inuit in Arctic Bay, tests will be conducted before and after local resource development.

In January, about 170 residents patiently queued up at the Indian band office for lengthy physical examinations.

"They really pulled out all the stops to help us," said Dr. Derek Eaton, a medical officer with the department of health and welfare. He said about 85 per cent of the permanent population has been examined.

Preliminary results of the physical tests should be available by the summer, he said. Long-term research will continue in 1982 and 1984.

The residents' blood, hair and urine was tested for heavy metal or organic contaminents. Dr. Eaton's team will also examine physician and hospital records to determine mortality patterns.

Band employees are interviewing each family about past illnesses and family nutrition. The natives' traditional food — including moose, beaver and bear — will be chemically analyzed.

Researchers will also try to assess the psychological and social impact of the megaprojects on community life.

In March, a continuous air monitoring system will be established to detect levels of sulphur dioxide, hydrogen sulphide, nitrous oxide, suspended particulates and dust fall.

When the project was announced, Chief Dorothy McDonald of the Fort MacKay Indian band said she was grateful for the "100-per-cent support" of federal health officials.

"The impact of the oil sands on our physical and mental health has never been measured but now we'll find out what's really going on," she said.

Environmental Monitoring Symposium

The Alberta Society of Professional Biologists is offering a symposium on environmental monitoring, April 20 - 21, at the Westin Hotel in Edmonton.

Guest speakers from universities, government and private industry will contribute. Featured speaker at the luncheon April 20 will be Monte Hummel, executive director of the World Wildlife Fund and at the banquet, also April 20, will be writer W.O. Mitchell.

Registration is through the society at Box 566, Edmonton T5J 2K8.

Community Energy in Camrose

The Camrose One World Centre has launched an energy efficiency "blitz" in that community. By using demonstrations, displays and a media campaign, the centre hopes to increase local people's awareness of the "growing importance of conserving our present energy resources."

"Eco-development" is the password, and is defined by the centre for cross-cultural learning as development which fulfills basic human needs, increases self-reliance and preserves the environment; and as a bridge between North America and the third world — "increased awareness of appropriate technology and the wise use of available resources."

The long term goal of the project will be to construct an energy efficient building to house the Camrose One World Centre and serve as a demonstration project. For further information call the centre at 672-9438 or write to 4802 - 49 Ave., Camrose.

Public Participation Seminar

The Banff Centre School of Management is offering the third annual seminar on Public Participation in Resource Management at the centre, April 18 - 22. The director of the course will be Barry Sadler, a lecturer and consultant based in Victoria. Other resource people include Phil Elder, Glen Farrell, Bruce Fraser and Jim Lotz.

To register, write The Banff Centre, Box 1020, Banff T0L 0C0.

If you have a short news item of province-wide interest you'd like to contribute to Environment Update, please send it to the editor at the address on the Contents page. The editor reserves the right to select and edit the items.